MASSACHUSETTS:

AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 449 SEPTEMBER 1948

Annual Report

For the Fiscal Year Ending June 30, 1948

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

UNIVERSITY OF MASSACHUSETTS

AMHERST, MASS.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

Trustee Committee on Experiment Station

	Term Expires
Brett, Alden C., Belmont, Chairman	1950
Cole, Frederick E., *Commissioner of Agriculture*	
Whitmore, Philip F., Sunderland	1948
Hoftyzer, Ernest, Wellesley	1950
McNamara, Mrs. Elizabeth L., Cambridge	1951
Deely, John M., Lee	1953
Hubbard, Clifford C., Mansfield	1953

Experiment Station Staff, June 30, 1948

Van Meter, Ralph A., *President of the University*

Sievers, Fred J., Director
Gaskill, Edwin F., Assistant to the Director
O'Donnell, Margaret H., Associate Director

Hawley, Robert D., Treasurer
Felton, F. Ethel, Editor
Mallory, Dorothy E., Secretary

*Alexander, Charles P., Entomology
Archibald, John G., Animal Husbandry
Bourne, Arthur I., Entomology
*Bradley, Leon A., Bacteriology
Brown, Alfred A., Agricultural Economics and Farm Management
Bullis, Kenneth L., Veterinary Science
†Chandler, Frederick B., Cranberries
Colby, William G., Agronomy
Doran, William L., Botany
Eisenmenger, Walter S., Agronomy
*Fellers, Carl R., Food Technology
†*Franklin, Henry J., Cranberries
*French, Arthur P., Pomology
Fuller, James E., Bacteriology
*Gamble, Philip L., Economics
*Gaskill, Edwin F., Station Service
‡Guba, Emil F., Botany
*Hankinson, Denzel J., Dairy Industry
Harris, William K., Veterinary Science
Haskins, Henri D., Agricultural Chemistry (Professor Emeritus)
Hays, Frank A., Poultry Husbandry
*Holdsworth, Robert P., Forestry
Holland, Edward B., Chemistry (Professor Emeritus)
Holmes, Arthur D., Chemistry
*Jeffrey, Fred P., Poultry Husbandry
Kightlinger, Clifford V., Agronomy
‡*Koon, Ray M., Horticulture
*Kuzmeski, John W., Dairy, Feed and Fertilizer Laws
*Lentz, John B., Veterinary Science
*Lindsey, Adrian H., Agricultural Economics and Farm Management
McKenzie, Malcolm A., Botany
*Mitchell, Helen S., Home Economics
*Osmun, A. Vincent, Botany
*Rice, Victor A., Animal Husbandry
*Ritchie, Walter S., Chemistry
Rozman, David, Economics
Shaw, Jacob K., Pomology (Professor Emeritus)
*Sieling, Dale H., Agronomy
Smith, Philip H., Agricultural Chemistry (Professor Emeritus)
Snoeyenbos, Glenn H., Veterinary Science
*Snyder, Grant B., Olericulture
Southwick, Franklin W., Pomology
Stapleton, Herbert N., Engineering
*Thayer, Clark L., Floriculture
Van Roekel, Henry, Veterinary Science
Wertz, Anne W., Home Economics Nutrition
‡Whitcomb, Warren D., Entomology
Wood, Basil B., Library

Esselen, William B., Jr., Food Technology
McLaughlin, Frederick A., Seed Law
Spelman, Albert F., Feed and Fertilizer Laws

Bailey, John S., Pomology
Becker, William B., Entomology
Bennett, Emmett, Chemistry
Clarke, Miriam K., Veterinary Science
†Cross, Chester E., Cranberries
‡Dempsey, Paul W., Horticulture
Fitzpatrick, Robert A., Agricultural Economics and Farm Management
Flint, Oliver S., Veterinary Science
‡Gilgut, Constantine J., Nurseryculture
Jones, Carleton P., Chemistry
Jones, Linus H., Botany
Kucinski, Karol J., Agronomy
Lachman, William H., Jr., Olericulture
Lojkin, Mary, Home Economics Nutrition
Mueller, William S., Dairy Industry
Smith, C. Tyson, Feed and Fertilizer Laws
Sperling, F. George, Veterinary Science
Spindler, Herbert G., Agricultural Economics and Farm Management
‡White, Harold E., Floriculture
‡Young, Robert E., Olericulture

Allen, Evelyn M., Veterinary Science
Anderson, Jessie L., Seed Law
Arnold, Avery A., Agricultural Economics and Farm Management
Barnes, Gladys, Poultry Husbandry
Bart, Joseph A., Feed and Fertilizer Laws
‡Bobula, Paul, Nurseryculture
Brown, Barbara E., Agricultural Economics and Farm Management
Chatel, Annela C., Agricultural Economics and Farm Management
Conklin, Joseph, Dairy, Feed, and Fertilizer Laws
Crosby, Earle B., Veterinary Science
§Crowley, Leo V., Feed and Fertilizer Laws
‡Donnelly, Edward B., Floriculture
Fox, Mary A. C., Veterinary Science
Gardner, Grace, Pomology
‡Garland, William, Entomology
‡Good, Philip N., Olericulture
Goulet, Fern A., Veterinary Science
Grady, Ruth E., Veterinary Science
‡Hood, Charles S., Entomology
Jewett, Felicia Z., Veterinary Science
†Kelley, Joseph L., Cranberries
Lambert, Doris, Veterinary Science
Martell, Joseph A., Dairy, Feed, and Fertilizer Laws
Merwin, Charles L., Veterinary Science
Miner, Gladys I., Botany
Moline, Jessie, Botany
Olesiuk, Olga M., Veterinary Science
Orrell, Blanche D., Veterinary Science
Parkinson, Leonard R., Home Economics Nutrition
Shaw, Priscilla, Home Economics Nutrition
Sherburne, Ruth E., Economics
Spear, Arthur J., Home Economics Nutrition
Stanley, Albert M., Veterinary Science
Talmadge, Daniel, Poultry Husbandry
Ward, Jean A., Agricultural Economics and Farm Management
Weeks, Walter D., Pomology
Wetherbee, Robert T., Feed and Fertilizer Laws
White, W. Henry, Botany
‡Wilson, Harold A., Horticulture
Yeoman, Grant M., Agronomy

*In charge †At East Wareham ‡At Waltham §On Military Leave

CONTENTS

ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1947-48

DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

The Effect of Public Regulation of Milk Marketing Upon the Organization of the Milksheds of Massachusetts Markets. (A. A. Brown.) Eastern fluid-milk markets and Boston in particular again had to reach into the North Central States for supplies during the fall and winter of 1947–48. The emergency short season turned out to be the longest on record.

Transportation rates and services are a major element in establishing the cost of this milk to dealers. To the rail information on these items, an attempt was made to add similar data for trucks. Movement by truck has not been undertaken regularly between the areas studied. Some shipments have been made and rates quoted but the preferred method of transportation is via rail tank car.

Shipments made by truck to other areas have been handled on a contract carrier basis at a minimum charge per load for which a maximum volume was set; viz., Juneau, Wisconsin, to Atlanta, Georgia, $431.50 for a load not to exceed 35,000 pounds. The comparable rail structure was $1.18 per 10-gallon can with a minimum of 2500 gallons. Expressed in terms similar to the rail tariff, the cost by truck in this instance was $1.06 per 10-gallon unit.

The transportation phase of this study has been completed. It has become increasingly apparent with the sustained shortages of fluid milk in the fall months that public regulation involves more than State Milk Control Boards and their Federal counterparts. Public health agencies and emergency commissions, such as the war-induced WFA and OPA, need, where possible, to integrate their objectives with those of the group regularly responsible for public milk supplies.

A Study of Farm Real Estate Taxation, Methods of Taxation Reform, and the Effect of Such Measures on Farm Income. (A. A. Brown and Avery A. Arnold.) Unreasonable variations in the valuation of farm property are due primarily to the basis on which valuations are made. Market value for tax purposes is difficult to determine at any time, and in periods of rising or falling prices practically impossible. A revision in point of view appears necessary if the inequities due to subjective valuation are to be minimized.

Real property for taxing purposes has a specific value; a value which may but probably will not be identical with market value. If this premise is tenable, the development and utilization of a classified property tax system would be a big step towards less unexplained variation in valuations.

Personal property for taxing purposes may have valuations determined even more realistically. But again agreement on the validity of the basic premise is a prerequisite. Market values as now used are nominal. They assume the exchange of the personalty, generally livestock, for its continued use unchanged except for ownership. The shortcomings of such assumptions appear in the variations in valuations. A common denominator for livestock of various kinds is its salvage value. The butcher's block is the great leveler. Since valuations

are established but once a year and since actual market values are published regularly, average meat values at primary markets—Boston, for example—during the month of November or December would be a more equitable value to apply.

For other personal property, especially machinery, a schedule of values could be devised similar in structure to that used for determining excise taxes on motor vehicles. Much machinery appears to be overlooked altogether, and one reason for this may be the difficulty of determining a reasonable value.

Marketing of Hatching Eggs. (A. A. Brown, B. E. Brown, and J. A. Ward.) Although not all the field schedules have been taken, some preliminary observations can be made.

The hatching-egg industry is made up of several components: broiler-hatching, flock replacement, foundation stock – R.O.P.

Under some conditions eggs from any mated pens go into broiler-hatching. Generally, however, buyers locally or in the principal outlet area—the Del-Mar-Va peninsula—determine the matings. The constant effort maintained by the broiler industry towards improving the product it sells adds to the hazard of specifying preferred matings. If producers of broiler-hatching eggs can anticipate these demands, their marketing problems become fewer. On a slow market, matings rather than price regulate the sale of broiler-hatching stock. Currently, stock of Barred Rock males mated with New Hampshire Red females is preferred by broiler-raisers. Since there is now some market for broiler-hatching eggs the year round, poultrymen with this stock are in a favorable position marketwise.

Seasonally the broiler-raising industry offers some opportunities to other Massachusetts flock owners who choose to take the risks involved. During late winter and in the spring when hatchings are being made here for replacement stock, the broiler territory is often an outlet for cockerels. During the summer and early fall the demands for hatching eggs are such that heavy fowl matings other than the Rock-Hampshire cross more readily. Both of these operations involve a large element of uncertainty. Since both operations are supplementary to the production of replacement stock, the possibility of large gains has outweighed the possibility of smaller losses in recent years.

Marketing of Massachusetts Potatoes. (R. A. Fitzpatrick, A. A. Brown, A. A. Arnold and A. C. Chatel.) Preliminary work incidental to providing adequate data on supply has been completed. The make-up of the industry, the acreage grown, and the varieties planted, underwent pronounced shifts during the war years.

Many small growers came into the industry or under the support price program became identifiable. The number of potato growers increased from 10,545 to 15,313 between 1939 and 1944. The number of small growers in 1945 was 14,000. Most of the increase in number appeared in this group.

Plantings increased 7,000 acres, nearly 50 percent, between these census years. Between 1942 and 1943 commercial acreage as measured by P & MA data increased about 3,000. In subsequent years some further addition was made so that by 1944 commercial acreage had increased by 4,000 out of a total shift of 7,000.

The noticeable increase in Katahdin acreage between 1939 and 1946 was at the expense of both Cobbler and Green Mountains, although Green Mountain acreage leveled off after 1944. Acreage of Chippewa, another newcomer during the thirties, was also greater than that of Cobblers by 1945 and has held there.

Storage information is not yet complete; however, it appears that few Massachusetts growers have permanent facilities for late holding.

Fluid Milk Prices in Major Northeastern Markets. (A. A. Brown, B. E. Brown and A. C. Chatel.) Work under this project has followed two lines, both of which should lead to a better approach to pricing in markets drawing milk from a common shed. Sales, supply, and producers' price data for the Worcester and Springfield markets have been brought up to date. In fulfillment of cooperative arrangements with the New England Research Council, milk-sales data were developed on a daily basis for the flush and short seasons in 1944 in the Northeastern States. Information on the rail movement of milk and cream from various common points in the shed into the New York and Boston markets was also made available. This material supplemented that provided by the Rhode Island and Connecticut stations.

Partial analysis of the data has been made along with tentative allocation of milk and cream sheds among the various markets.

Philadelphia's low price with the substantial differences at major markets to the North and South of it is one of the potentially more significant findings. The assumption had been that New York City was or would be the base market.

Of additional interest will be the closeness with which the theoretically determined short-season milk and cream supply areas approximate the historical relationship for Boston and New York.

DEPARTMENT OF AGRICULTURAL ENGINEERING

H. N. Stapleton in Charge

Forage Handling Investigations. (H. N. Stapleton.)

Barn Hay Drying. The application of high-volume fans supplying unheated air for mow drying has been made for the purpose of improving the efficiency of the barn drier. Since farm electric lines usually limit the size of electric motors to 5 or 7½ HP a fan selection which increases air volume per horsepower permits greater drying capacity with this limited power.

By pretesting large-diameter 2-blade propeller fans in a blast-gate tunnel, a tentative selection of satisfactory sizes for 3 HP and 5 HP motors has been made. Wind tunnel work also showed that, without the standard 1-diameter length of discharge tube permitted by the manufacturer's test code for determining fan ratings, a standard fan will not deliver the air volume of which it is capable when the tube is applied. The use of additional mounting rings from larger diameter fans to bell-flare the inlet was significant in improving the performance of the fan except near free delivery and near blockoff. The bell-flare also decreased significantly the noise level of these fans. No significant advantage could be found from the use of a ¼-diameter torpedo hub mounted in the discharge tube.

The application of 5 HP on a 2-blade 54″ propeller fan with 60″ ring and 1-diameter length discharge tube added proved satisfactory in one of the barn mows on the University Farm. Serving a 34′ x 72′ mow through a centrally located main duct, slatted its entire length, a maximum static pressure of 7/16″ water column was developed. The calculated delivery of the fan was 35,000 cfm or more throughout the drying period. The calculated water load placed at one time and to be removed by the forced air was 15,300 pounds. Satisfactory drying conditions were obtained.

The use of 3 HP on a 2-blade 40″ propeller fan with 44″ and 48″ rings added, but without a discharge tube, on an air scoop for drying baled hay permitted the drying of bales on a mow floor without the use of a previously constructed air distribution system. Bale width tunnels, two bales in height, leading from the air scoop through the length of the pile of bales permitted air escape both between and through the bales with heights up to eight tiers. Satisfactory drying was obtained with calculated water loadings up to 8000 pounds. Static pressure developed within the air scoop at no time exceeded 3/8″ and the calculated delivery of the fan was never less than 22,000 cfm.

Satisfactory drying is considered to be obtained when there is no mold development and when during and after the drying operation the hay emits an aroma rather than an odor. It is considered that the practical limit of water loading for these fans has been reached, as the time required to reduce the moisture content of the hay to 25 percent with these loadings has been 4 days.

Warm Room Brooding. (H. N. Stapleton.) The use of a hover-convector shield with a wall-mounted pipe panel has indicated that with restricted ventilation the temperature gradient across the floor of a narrow room can be made quite uniform. With this equipment, crowding to 0.3 square foot per chick, with two different ages in the room, was possible under warm room conditions. The warm room, together with the crowding, was considered to give a slower rate of both growth and feathering than was obtained with the same stock under other brooding conditions.

DEPARTMENT OF AGRONOMY

Dale H. Sieling in Charge

The Fixation of Phosphate by Iron and Aluminum and Its Replacement by Organic and Inorganic Ions. (Dale H. Sieling, Richard M. Swenson, and C. Vernon Cole.) It has been observed that hydrous oxides of iron and aluminum and solutions of iron and aluminum salts will fix phosphate by chemically combining with the phosphate at low pH values. The compounds formed were shown to be the hydrated basic phosphates of iron and aluminum represented by the formulas: $Fe(H_2O)_3\ (OH)_2\ H_2PO_4$ and $Al(H_2O)_3\ (OH)_2H_2\ PO_4$. The conclusion that the compounds were basic phosphates rather than normal phosphates was based on the observation that for each iron or aluminum ion one phosphate and two hydroxyls were required for complete precipitation. If the normal phosphate were formed, one phosphate and no hydroxyl would be required to completely precipitate each iron or aluminum ion.

The amount of phosphate which would combine chemically with one iron or aluminum ion increased as the phosphate increased up to a value where one phosphate was combined with one iron or one aluminum ion. In no instance was the ratio of phosphate to iron or aluminum in the precipitated compound greater than unity even when the amount of phosphate present was nine times that of the iron or aluminum.

Arsenate reacted with aluminum in the same manner as phosphate but was found to be about one-fifth as effective in replacing chemically combined phosphate as was phosphate in replacing chemically combined arsenate. Fluoride reacted with aluminum in the same manner as phosphate and arsenate and, when

in large excess, the fluoride caused the formation of the soluble hexa-fluo-aluminate ion. Fluoride was effective in replacing chemically combined phosphate and arsenate. The effectiveness increased progressively as the concentration increased until it was complete when the ratio of fluoride to aluminum reached six.

Organic anions were effective in replacing phosphate which had been chemically combined with iron or aluminum. Citrates, gallates, iso-ascorbates, tartrates, and mucates were particularly effective; while gluconates, hydroxybenzoates, and salicylates were less effective, and amino acids were not effective at all. Only those anions possessing the property of forming stable complexes with the iron or aluminum were effective in replacing the phosphate with which these metal ions were chemically combined.

Purified lignin and humus replaced chemically combined phosphate from basic iron phosphate. An increase in hydroxyl concentration also was effective in replacing chemically combined phosphate; however, its effectiveness was less than that of some of the organic anions.

Practical applications of the findings are suggested as follows:

1. An increase in the actively decomposing organic matter and in the pH value of an acid soil would result in the release of fixed phosphate and aid in preventing further phosphate fixation.

2. Soluble fluorides might be employed to release fixed phosphates. This would be practical in those areas where fluorides are known to be deficient in soils and water supplies. This fluoride deficiency has been shown to be related to a nutritional deficiency in both man and animals which results in the development of poor tooth and bone structure. The use of fluoride would then have the two-fold effect of releasing chemically combined phosphate and increasing the fluoride content of the crops and the water supplies.

3. Many soils are made unusable for shallow-rooted crops because of the use of excessive quantities of arsenates to control insect pests. In these cases arsenates are fixed in the topsoil in large quantities. To remove the arsenate from the topsoil and to cause its transfer into the subsoil, one could treat the topsoil with phosphates, fluorides, lime, or organic matter, or combinations of these materials. Shallow-rooted crops could then be grown on the reclaimed soils after appropriate fertilization.

The Absorption of Chemical Elements by Food Plants. (Walter S. Eisenmenger and Karol J. Kucinski in cooperation with C. Tyson Smith, Feed and Fertilizer Control Laboratory.) The object of this project is to determine the factors which influence the intake of elements in plants. The relative intake by plants of calcium, magnesium, potassium, and sodium was studied when applied singly and in pairs. Sulfates, phosphates, chlorides, bromides, and iodides were also determined in tissues of plants grown on soils treated with these anions.

Analysis of seedlings grown in the greenhouse showed that the addition of copper lowered the movement of magnesium from the nutrient medium and the seed to the aerial portion of the plant. When copper was applied to soil in field plots, the magnesium intake by plants was not lowered. However, when copper and calcium were applied together in the field plots, the amount of calcium absorbed by the plants was appreciably higher than where the same amount of copper and calcium was applied singly.

In another phase of this study, where sodium fluoride was applied to the soil, the fluorine content of the plants increased proportionately with the increasing rate of sodium fluoride applications to the soil.

The Relationship of Plant Development to the Capacity to Utilize Potassium of Orthoclase Feldspar. (Walter S. Eisenmenger and Cornelius C. Lewis.) Twenty-two seed plants of varying degrees of development were grown in soil in three series. To one series no potassium was added; to another, potassium chloride; to the third, feldspar in quantity equivalent in potassium content to the second series. At maturity the potassium content of the plants was determined by chemical analysis, and percentage gains in all series were computed.

The percentage gain of potassium from both soluble and insoluble sources tended to decrease as the plants ascend from the lower to the higher order of development.

In the control medium, plants of the lower orders showed deficiency symptoms earlier than those of the higher orders.

The lower developed plants, such as larkspur, rape, poppy, lespedeza, velvet leaf, and geranium, absorbed a larger quantity of potassium from the orthoclase feldspar than did the more highly developed plants such as lettuce, sunflowers, sage, and spinach. With few exceptions, the lower the plant in its development, the more easily it secured potassium from relatively insoluble sources.

Magnesium Requirements of Certain Plants. (Walter S. Eisenmenger and Karol J. Kucinski.) The need of plants for magnesium to maintain normal physiological processes is not easily determined because the amounts of the element required by different species are not the same. The magnesium requirement is higher for garden crops than for such crops as wheat, rye, or oats. Some of the hybrid varieties of corn are seemingly unable to secure sufficient magnesium from magnesium-deficient soils where open-pollinated corn may grow normally. With the exception of a few botanical families, the more highly developed plants do not show magnesium deficiency symptoms to the same degree as do the lower orders of plants. This may mean either that the lower orders of seed plants need more magnesium or that they are more sensitive to abnormal conditions.

The pH of a soil influences the degree of magnesium deficiency. On a soil which was magnesium-deficient and which had a pH of 6.8, there was less chlorosis and growth was less retarded than on a magnesium-deficient soil where the pH was 4.5. This is probably due to the more rapid washing out of the magnesium ions from the weathering rock particles under lower pH conditions. Magnesium-deficiency symptoms are not usually present where the soil has a high pH value or high organic matter content. It has been observed that magnesium deficiency in plants is associated with soils having a low base exchange capacity.

When magnesium salts are applied to a soil where annuals are grown, an increase in the magnesium content of the plant tissue is found. This is not true for all perennials. Certain species of perennials, as they grow older, seem to lose their capacity to increase their magnesium content.

Magnesium Deficiency Investigations. (W. S. Eisenmenger and Dale A. Hinkle.) Analyses of leaves from 18 different species of plants which were grown on magnesium-deficient and magnesium-treated plots showed that a deficiency of magnesium in the soil greatly reduced not only the chlorophyll content of leaves but also the xanthophyll and carotene content. Coefficients of correlation between the losses of any two of the three pigments were high and positive. When the chlorophyll content was used as a criterion of magnesium deficiency, it appeared that, for the most part, those plants low in the scale of evolutionary development suffered more from magnesium deficiency than plants higher up in the scale.

A greenhouse study was made to determine the effects of the cations in the alkali group of the periodic table upon the absorption of magnesium by tomatoes. Lithium at the rate of 30 parts per million proved toxic when applied to Merrimac sandy loam. The addition of 300 parts per million of potassium, 125 parts per million of rubidium, or an equal amount of cesium had no effect on the amount of magnesium absorbed, or on the degree of chlorosis of the lower leaves as compared with a check treatment in which nothing was added. However, all these treatments, as well as the check treatment, resulted in significantly less magnesium absorption and less pigment production than a treatment in which magnesium was added. Sodium at the rate of 300 parts per million overcame magnesium deficiency to some degree as was shown by the absence of chlorosis of the leaves and a slightly higher uptake of magnesium.

Magnesium sulfate applied around apple trees at the rate of 5, 15, and 25 pounds per tree failed to increase the magnesium content of the leaves.

Yields were recorded for nine vegetable and berry crops grown on plots which were known to be deficient in magnesium. One plot was treated with magnesium alone; a second with magnesium and lime; a third with lime alone; and a fourth received neither magnesium nor lime. All plots received 1 ton per acre of 5-8-7 fertilizer especially prepared to contain no magnesium. Blueberries yielded highest where neither lime nor magnesium was added; tomatoes and eggplant, where magnesium alone was added; beets and cabbage, where magnesium and lime were added; and raspberries, peppers, string beans, and carrots, where lime alone was added.

The results of the studies on vegetables indicate the importance of magnesium in vegetable fertilizers, since a high carotene content is desirable from a nutritional standpoint.

Tobacco Quantity and Quality Following Early Fall Application of Nitrogen Fertilizer. (Walter S. Eisenmenger and Karol J. Kucinski.) When tobacco is grown following such crops as corn, clovers, and grasses, which are high in lignin, symptoms of brown rootrot are more likely to occur. Micro-organisms instrumental in decomposing tissues containing much lignin need an abundance of nitrogen and consequently rob the tobacco plant temporarily of this element. Nitrate of soda at the rate of 0, 50, 100, 200, 300, and 500 pounds of nitrogen per acre was applied to some hay plots in the early fall and to others in the spring before the plots were plowed. In nearly all cases, these treatments resulted in increased yields and improved quality of the tobacco grown on these plots; however, the higher rates of 300 and 500 pounds of nitrogen did not greatly increase the yield over the lower rate of 200 pounds. Those plots plowed in the early fall showed a greater response to nitrogen than those similarly treated but plowed in the spring. The micro-organisms apparently need the warmth of the early fall to act more fully on the plant tissues plowed under.

In a similar experiment where corn was plowed under, the yield and quality of the succeeding crop of tobacco was best where the corn was plowed under in the early fall.

Chloropicrin for Tobacco Seedbed Sterilization. (C. V. Kightlinger.) Chloropicrin has been used extensively by Massachusetts tobacco growers during the last few years to sterilize tobacco seedbeds and, in general, it has been satisfactory. However, in 1947, some seedbeds which had been sterilized with chloropicrin in the fall of 1946 were almost total failures. Some growers attributed these failures to the presence of residual chloropicrin which had not evaporated because of the low soil temperature which followed its application. Many grow-

ers are now afraid to use chloropicrin for soil sterilization and, owing to the general unavailability of steam sterilization, they have no satisfactory substitute.

The object of this experiment was to determine whether late fall sterilization of tobacco seedbed soil with chloropicrin would cause poor germination and growth of tobacco seeded the following spring. Other factors affecting the production of tobacco seedlings were also studied.

Four seedbed plots, 30 feet long and 6 feet wide, each received 25 pounds of a 8-4-8 tobacco fertilizer: two in late October, 1947, and two shortly before seeding time in the spring of 1948. One of each pair of plots was sterilized with chloropicrin in late October, 1947; the other two were not sterilized. The soil temperature of the plots was about 50° F. at the time of treatment with chloropicrin and remained low for the rest of the fall. The observed results were as follows:

Plot I. *Fall Fertilized and Sterilized.* The germination of seed was very good; the seedlings grew well and weed control was good. The productivity as well as the weed control in this plot was equal to that obtained in another seedbed which had been sterilized with chloropicrin and fertilized early in September. At that time the temperature of the soil was well above 60° F. and remained so for a considerable time.

Plot II. *Fall Fertilized but Not Sterilized.* The stand and growth of seedlings were good but not so good as on Plot I. The weed infestation was heavy.

Plot III. *Fall Sterilized and Spring Fertilized.* The stand of seedlings was very poor with no plants at all occurring in large areas. The seedlings grew poorly throughout the season. The weed control was good but less effective than on Plot I. Possibly the poor stand of tobacco seedlings offered less competition to those weeds which survived the sterilization, and thus the weeds grew more vigorously.

Plot IV. *Spring Fertilized but Not Sterilized.* The stand of tobacco seedlings and their subsequent growth was poor throughout the season. Weed infestation was heavy but somewhat less than on Plot II.

The general conclusions and practical applications of these observations are: Chloropicrin, although applied late in the season, was apparently not the cause of the seedbed failure in this trial. The failure of the seedbed was attributed to effects of the spring application of the fertilizer. It is believed that tobacco seedbeds should be fertilized in the fall or at least a considerable time before the seeding if the fertilizer is applied in the spring.

Fertilizer Placement for Potatoes. (C. V. Kightlinger and H. M. Yegian.) It is the purpose of this project to determine how different ways of applying fertilizer affect the growth and yield of potatoes.

Fertilizer of 5-10-10 formula was used at the rate of 2200 pounds per acre and was applied in three ways: all banded; half banded and half broadcast; and all broadcast. The broadcast fertilizer was harrowed into the soil thoroughly before the potatoes were planted. The banded fertilizer was applied in the usual manner by the potato planter.

The plots were one-twelfth acre in size and were replicated four times. Green Mountain potatoes were planted about the middle of May and were sprayed with Bordeaux mixture at weekly intervals from the middle of June until frost killed the vines in late September, with DDT and nicotine used as needed to control insects.

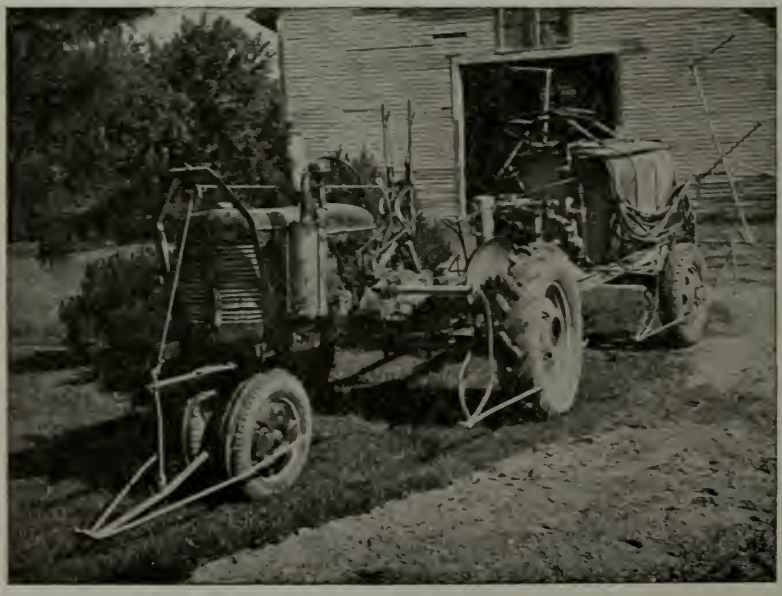
Plots where the fertilizer was all banded produced much better growth of vines and much larger yields of potatoes: 23 percent more marketable potatoes than the plots on which the fertilizer was half banded and half broadcast, and 51 percent more than the plots on which the fertilizer was all broadcast. Also, con-

siderably fewer B grade and cull potatoes were obtained from the plots on which the fertilizer was applied all banded than from the other plots.

Potato Vine Lifters. (Karol J. Kucinski.) When potato vines become large enough to cover the space between the rows, the moving of spraying equipment through the field crushes the vines, thus causing a decrease in yield. An improved vine lifter has been developed which will pick up the vines from the space between the rows and push them back into the rows. This allows the passage of the wheels of both the tractor and the sprayer without injury to the plants.

The lifters were patterned after those developed by John W. Slosser, Engineer, Research Division of the Soil Conservation Service, in cooperation with the Maine Agricultural Experiment Station. Certain modifications of the basic design were made to improve the operation and utility of the lifters.

Each lifter is attached to its control by means of a clevis and pin coupler to make its removal from the tractor easy. The vine lifters for the tractor rear wheels are suspended from the arms which usually carry the cultivators and can be operated hydraulically. The vine lifter for the front tricycle wheel is suspended by a small rope attached to the hanger rod of the lifter and through a pulley to the hand-lever used in connection with the cultivator. The two lifters for the wheels of the sprayer are suspended from an arm attached to the sprayer frame and the hand-lever is used to adjust the lifters and can be operated from the driver's seat. The lifters are made of ¾" steel rod and the hanger arms from 5/8" steel rod. The lifters for the tractor would be designed as required for each make and model. The accompanying illustration shows the vine lifters attached to the sprayer and the tractor.



Simple-to-Make Potato Vine Lifter Attached to Tractor and Spray Rig.

Tests of Spray Materials for the Control of Late Blight of Potatoes. (C. V. Kightlinger and H. M. Yegian.) It is the object of this investigation to compare the effectiveness of some of the newer fungicides with the standard Bordeaux mixture for controlling late blight of potatoes, and to determine the effect of these materials on vine growth and production.

In 1947 the investigation was confined to the use of Bordeaux mixture, neutral copper (COCS), Dithane 14, and Dithane 278. Test plots of one-thirtieth acre were established for each kind of fungicide and for one check treatment where no fungicide was used. The plots were all replicated four times and were randomized. Green Mountain potatoes were used as the test crop and were sprayed with recommended rates of fungicide at weekly intervals from mid-June until frost killed the vines in late September. Insects were controlled as needed with sprays containing DDT and nicotine.

Late blight occurred too lightly in 1947 to make the results conclusive; however, the more evident observations can be summarized as follows:

1. Bordeaux mixture was the most effective of the fungicides tested for controlling late blight, but it caused a noticeable depression in the growth of the plants.
2. Neutral copper, Dithane 14, and Dithane 278 were about equally effective in controlling late blight, but were less efficient than the Bordeaux mixture. These materials did not depress the growth of the vines significantly.
3. With all of these fungicides, spraying at weekly intervals was not sufficient to completely control the blight during the time the plants were growing the fastest.

Potato Variety Trials. (Karol J. Kucinski and Ralph W. Donaldson.) Eight potato varieties commonly grown in this region have been tested annually with respect to their yielding qualities. Based on 10 to 14 year averages, the varieties rank themselves in the following order: Green Mountain, 436 bushels; Chippewa, 368; Russet Rural, 364; Houma, 342; Warba, 336; Irish Cobbler, 308; and Sebago, 305 bushels.

Soil Conservation Research Projects. In cooperation with the Research Division of the Soil Conservation Service, United States Department of Agriculture. (Karol J. Kucinski, Project Supervisor.)

A Survey of Erosion Problems Arising from Changes in Soil Use. The commercial growing of potatoes in the western foothills and plateaus of Massachusetts has become well established during the past few years. Old sod and pasture lands which have not been plowed for as many as thirty years are now being cleared and put into potato production. Since the potato fields are rather large areas located on sloping hillsides, where the season does not permit the use of winter cover crops, considerable soil erosion has taken place. Periodic analysis of the soil taken from selected areas shows that in nearly all cases the organic matter content has decreased more than 50 percent from what it was five or six years ago. The farmers realize that their soils are deteriorating rapidly, and are calling on the Soil Conservation Service "Operations" for technical aid in solving their problems of erosion and soil depletion. Contour planting, terracing, and rotation with green manure crops are the control measures recommended.

Studies to Determine the Effects of Loss of Top Soil on Crop Yields. In order to illustrate the value of top soil and organic matter, a field experiment was initiated, in which the top soil (to plow depth) was totally removed from a plot

while an adjacent plot was left undisturbed as a check plot. Spring wheat, white sweet clover, winter rye, and buckwheat were grown on fertilized and unfertilized portions of these two areas. The decrease in yield due to top-soil removal ranged from 63 to 81 percent for the fertilized areas and from 91 percent to complete crop failure for the unfertilized areas.

The Investigation of Beach Grass. The native or American beach grass (*Ammophila breviligulata*) found commonly on Cape Cod has been used successfully in the stabilization of beach areas and coastal sand dunes. A heavy type of transplanting machine which has been developed recently is capable of planting about six acres a day. The use of this machine has made it economically feasible to transplant beach grass and has created a demand for large quantities of transplanting stock. There are some indications that fertilization of natural beach grass will tend to increase the stands and thus provide more and better propagating stock per given area.

Studies are in progress to determine what response beach grass will make to fertilization and liming, in the natural state and after it has been transplanted.

Investigations with Various Winter Cover Crops for Onion and Potato Fields in the Connecticut River Valley. The date and rate of seeding and kind of cover crop used depend somewhat on the preceding and succeeding crop. For several years such crops as winter rye, barley, oats, buckwheat, domestic rye grass, and Italian rye grass have been seeded at weekly intervals from the beginning of September through the last week in November. Winter rye, oats, and barley produced excellent cover when they were sown in September and early October; fair to medium cover when seeded from middle to late October; and poor cover when seeded during November, especially during the last week of November, when growth was considered unsatisfactory. Not very much stooling resulted when these crops were seeded after the middle of October. Italian or domestic rye grass and buckwheat do well when seeded in early September. Rye grass, when planted early, produced a thick mass of fine roots, which may be superior to the coarse roots of the cereal plants for the prevention of water erosion. Some rye grass may survive mild winters, and this should be taken into consideration if seedings are made in fields to be used for certain crops like onions where it is not the custom to plow in the spring. Barley and oats, which winterkill yet produce a desirable protective mat cover, may be used in onions and other small-vegetable fields. The mat thus produced can be easily disked and will not interfere with the preparation of the field in the early spring. Buckwheat can be used as a green manure crop, catch crop, or cover crop, but is not satisfactory as a winter cover crop. It is killed by the first light frost, and the mat produced on the soil surface is not a sufficient protection against erosion.

The rate of seeding for oats, winter rye, and barley is 1½ to 2 bushels per acre, and the larger rate should be used if seeding is made during October. For Italian or domestic rye grass, when used as cover crops, 25 pounds per acre has been found to be a desirable rate of seeding, and for buckwheat about 35 to 40 pounds.

Use of Snow Fencing in Controlling Wind Erosion. Farmers in the Connecticut Valley have the problem of protecting their soils and crops from wind damage. The winds which occur during early spring result in losses of soil, seed, fertilizer, and young crops. This damage usually occurs at particular areas on a farm, called "blowouts." To control these local "blowout" spots temporarily until the crop has established itself, some form of windbreak may be used. Trials have shown that snow fencing is satisfactory for this purpose. The cumbersome

guy-wires generally used in connection with the fencing for protection against snow drifting are not necessary when the fencing is used for wind erosion control. Old iron pipes or wooden stakes 4½ to 5 feet long, driven 18 inches into the ground and spaced a rod apart, will hold the 4-foot-high lath fencing throughout the entire season. If the fencing is placed on the windward edge of the "blowout" at right angles to the prevailing winds and the crop rows are placed parallel to the fencing, very little loss of tillable area or inconvenience in operation of farm machinery will be experienced. One fence row is usually sufficient to control "blowouts" of the size commonly found in this section.

Breeding Work with Orchard Grass. (W. G. Colby.) This project was described in the Annual Report for 1945 (Mass. Agr. Expt. Sta. Bul. 428, p. 13). The orchard grass strain, Finnish Late Hay, has continued to give good results when grown with alfalfa or Ladino clover. The strain has received some criticism for lack of vigor. However, for growing with Ladino clover, less vigorous strains are desirable because they do not crowd out the clover two or three years after seeding; for use with alfalfa the competitive factor is not so important.

Breeding work has been progressing in an effort to select vigorous late-maturing plants, and several such plants have been isolated during the past year. Whereas commercial orchard grass reached the bloom stage by June 12, several of these late-maturing selections did not reach bloom stage until June 28. Most of the late-maturing orchard grass strains are susceptible to winter injury, especially in the seedling stage. Finnish Late Hay is as hardy as most commercial strains. Attempts to test the winter hardiness of these late-maturing selections failed last year because of the heavy ground cover of snow throughout most of the winter.

Red Clover Variety Trials. (W. G. Colby.) Seed for the varieties included in these trials was supplied by the U. S. D. A. Bureau of Plant Industry. Following are the varieties tested in 1947: Midland, Dollard, Ottawa, Wisconsin Mildew Resistant, Cumberland, Southern Selection, Kentucky Selection, and New Hampshire Perennial. The three southern anthracnose-resistant strains, Cumberland, Southern Selection, and Kentucky Selection, have proved to be winter hardy and have given just as good if not better performance than the best northern strains. Kentucky Selection and Southern Selection in particular were outstanding. Plots seeded in the spring of 1946 still had a 20 percent stand by the spring of 1948. Comparable plots of Midland clover, a recommended northern strain, had less than a 5 percent stand. Results thus far indicate that seed companies supplying seed of some of the anthracnose-resistant strains to southern clover-growing sections could, when seed supplies are adequate, use seed of these same varieties for northern red clover-growing sections.

Trials with New Oat Varieties. (W. G. Colby.) Heavy summer thunder showers caused serious lodging with all varieties included in the oat variety test carried on in cooperation with the U. S. D. A. Division of Cereal Crops. Three varieties, Ajax, Clinton, and Mohawk, although seriously lodged, nevertheless gave good yields of fair quality grain. Ajax and Clinton have been grown for several years and both varieties have been outstanding for their resistance to lodging and have also ranked high in grain yields. Mohawk was grown for the first time in 1946. Although not among the highest-yielding varieties in 1946, its stiff straw was an outstanding characteristic.

Trials with Alfalfa Strains and Selections. (W. G. Colby.) In the spring of 1946 an alfalfa nursery was planted which included some 60 selections and varieties of alfalfa. Standard varieties such as Kansas Common, Oklahoma Common, and Baltic, and newer varieties such as Buffalo, Ranger, and Atlantic were all grown with some 50 clonal selections from Nebraska and Kansas. Few differences have been noted in the performance of these strains. Several of the newer strains are resistant to the bacterial wilt disease but since there has been no evidence of this disease up to the present, the resistant varieties have been no better than any of the other varieties and selections. It is questionable whether a farmer in Massachusetts is justified in paying premium prices for seed of wilt-resistant varieties of alfalfa like Ranger or Buffalo unless he knows that this disease is a serious problem on his farm.

Onion Breeding. (Hrant M. Yegian.) The tendency to produce doubles is found in all varieties of set type onions, *Allium cepa* L. The size of the set and the environmental factors are considered to play an important part in the appearance of this undesirable character. Sets over three-quarters or one inch in diameter are more likely to produce double bulbs during favorable growing seasons than the sets under three-quarters of an inch. Some variations, however, occur in the double bulb frequencies in sets of different varieties but of the same size. This would suggest that inherent differences in susceptibility to produce doubles exist in the several varieties.

In an endeavor to obtain a further understanding of the causes of doubles in set onions, various local Ebenezer varieties were selfed and selected. In one instance a double set attached together at the base was produced from the selfed seed of one of the selections. Cases of double sets from a single seed are rare. This newly found case strongly suggests that the character of doubles in onions is probably of a genetic nature.

DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

A Study of the Mineral Elements of Cows' Milk. (J. G. Archibald.) The element nickel has been studied during the past year. Procedure has been the same as that outlined for other elements in earlier reports. Eight cows were used for the study (two each of the Ayrshire, Holstein, Guernsey, and milking Shorthorn breeds); the supplement, nickel(ous) chloride, was fed at the rate of 500 milligrams (approximately 125 milligrams of elemental nickel) per cow daily. Much of the time spent on the project was devoted to perfecting a method which would detect minute traces of the element (of the order of five parts per billion or less).

The analytical work on the season's milk samples has been completed; although the trend was toward an increased amount of nickel in the milk when the cows received the supplement, the results were not uniform and not statistically significant. This is believed to be due to imperfections of method; it is therefore planned to make further study of methods and technique and to repeat the trials next year.

A Study of Quality in Roughage: Composition, Palatability, and Nutritive Value of Hays as Affected by Curing, Harvesting, and Storing Procedures. (J. G. Archibald, M. L. Blaisdell, and H. N. Stapleton.) Twelve lots of hay have been studied, involving the analysis of 50 samples. Nine of these lots were

from the College Farm; three from cooperating farmers. In addition to regular fodder analysis, sugar and carotene were determined in all samples. The chemical changes which take place in the hay from cutting time to feeding time (often 3 to 6 months) were followed closely for all lots of hay from the College Farm and for one lot from a farmer cooperator. Factors studied were exposure to prolonged sunlight; exposure to rain; field curing and storing as loose hay; field curing and storing as baled hay; barn drying of loose hay; and barn drying of baled hay. One feeding trial with two milking cows was conducted over a four-month period.

Action of either bright sunlight or rain for two days reduced carotene content of field-cured hay at loading time to about a third of its initial value. Sunlight, although it caused some lowering of the sugar content, had a much less adverse effect on sugar than on carotene.

Barn drying of either loose or baled hay may have possessed some initial advantage over field curing in conservation of carotene; but by the time the hay had been in storage several weeks, this advantage had largely disappeared, owing apparently to adverse storage conditions (high mow temperatures). This was also true to a lesser extent for sugar. Sugar content of some lots of hay was markedly reduced in storage, regardless of method of curing; this is thought to be due to the fact that the hay was stored too wet and/or to trouble with blower installations.

The advantages of baling and barn drying may be entirely offset by attempting to barn-dry either baled or loose hay at too high moisture levels. Tentatively 40 to 45 percent of moisture is suggested as the upper limit for safe storage over a barn dryer.

From the standpoint of carotene and sugar conservation, present methods of curing and storing hay need further study. There is some evidence to show that where a blower is operated efficiently, sugar is quite well conserved; but if farmers are interested in saving as much carotene as possible, good silage seems to be the answer in the present state of our knowledge.

The feeding trial was conducted with hay in which the sugar content had been greatly reduced (from around 6 percent to about 2 percent) by adverse curing conditions. When this hay was supplemented with sufficient crude glucose syrup to bring the total sugar intake back to normal, the cows produced 1.1 pounds more milk (4%—F.C.M.) daily than when the supplemental sugar was withheld. Shrinkage in milk flow from month to month was 1.6 percent when the syrup was fed and 7.8 percent when it was withheld. Whether this favorable result was a specific effect of the added sugar, or whether it simply represented a response to increased intake of total digestible nutrients is not known. Further light on the question will be sought this coming season by using a larger number of cows in a comparison of two kinds of hay, similar in character, except that one will have normal sugar content, while the other will be designedly low in sugar.

DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

Survival of Escherichia coli from Sewage in Soil of a Septic Tank Disposal Field. (James E. Fuller.) This study was prompted by the failure to recover *Escherichia coli* from the soil of the disposal fields of an experimental septic tank installation (Mass. Expt. Sta. Bul. 441, p. 17, 1947). In the present project pure cultures of *E. coli* are being inoculated into soils, both sterilized and non-

sterilized, and their survival in the soils is determined by accepted cultural procedures. The work is still in a preliminary stage, but results indicate that the organism survives for only a few weeks under optimum conditions of moisture and temperature. The results of the study reported in Bul. 441, and of an earlier one (Study of septic tank efficiency, Mass. Expt. Sta. Bul. 436, p. 17, 1946), have been published as a Station bulletin (Mass. Expt. Sta. Bul. 446).

Bacteriological Study of Sewage Sludge. (James E. Fuller.) Previous experience in this laboratory had shown that *Escherichia coli* from sewage disappears in a comparatively short time when sludge from a sewage disposal plant is put onto a sand filter bed. The present study was undertaken to determine the reasons for this disappearance and thus to provide some basic information concerning the physiology of *E. coli* and its relation to its environment. The results will be correlated with those obtained from the study of the soils of septic tank disposal fields.

To date two possible causes have been considered that might be responsible for the disappearance of *E. coli* from sludge. The first was the presence of some antagonistic biological factor such as bacteriophage or antibiotic substances produced by associated microorganisms in sludge. Results failed to indicate any such factor. The other possibility was that other microorganisms might offer competition, especially for nutriment, with which *E. coli* cannot compete successfully in sludge. *E. coli* is a normal inhabitant of the human intestine where it has optimum temperature and easily utilizable simple organic sources of carbon and nitrogen. When sludge was placed on a sand filter in the laboratory and held at room temperature, *E. coli* disappeared after 14 days, while *Aerobacter aerogenes* and other soil types of *coliform bacteria* persisted. At body temperature (37° C.), *E. coli* survived up to 56 days, and *A. aerogenes* survived much longer This suggested a temperature influence, since *E. coli* is accustomed to the temperature of the human body. When organic food substances (dextrose and peptone) were added to sludge, *E. coli* survived for 21 days, whereas it had disappeared in 14 days without the added nutriment. Sludge, from which *E. coli* had disappeared, was sterilized in an autoclave to destroy competing microorganisms. *E. coli* was inoculated into the sterile sludge and has survived for 42 days. These results all favor the competition theory as an explanation of the disappearance of *E. coli* from sludge.

Effect of Volatile Disinfectants on Survival of Microflora in Soil. (Charles Hurwitz and Frank H. Dalton.) These studies were undertaken to provide a method for sterilizing soil for laboratory studies which would permit subsequent removal of the sterilizing agent and would cause a minimum of change in the soil itself. A sealed jar containing the soil sample was evacuated and the atmosphere saturated with one of the following volatile disinfectants: chloroform, hydrogen cyanide, chloropicrin, formaldehyde, and ethylene oxide. The rate of survival of the soil microflora was determined by plate counts and by broth-culture inoculation techniques. Ethylene oxide sterilized the soil after 11 hours exposure, formaldehyde after 3 days, and chloropicrin after 8 days. Hydrogen cyanide and chloroform decreased the numbers of viable microorganisms but did not sterilize the soil after 8 days exposure.

The extractability of copper and manganese from the soil with ammonium acetate was used as an indication of changes brought about in the soil as a result of exposure to the disinfectants. Contact of the soil with formaldehyde caused a 187 percent increase in extractable copper. With ethylene oxide the increase was 309 percent; and with chloropicrin, 444 percent. Extractable manganese

increased from 0.14 p.p.m. in the untreated soil to 2.5 p.p.m. in the soil treated with ethylene oxide, 7.7 p.p.m. in the soil treated with formaldehyde, and 21.7 p.p.m. in the soil treated with chloropicrin.

It is interesting to note that the use of formaldehyde and chloropicrin resulted in possibly toxic concentrations of manganese. These two fumigants are widely used in seedbed preparation.

Two papers entitled "Effect of volatile disinfectants on survival of microflora in soil" and "The effect of sterilization of soil upon the solubility of soil copper and manganese" have been submitted to Soil Science and Florists' Exchange, respectively, for publication.

Microbiological Fixation of Copper in Soil. (Charles Hurwitz.) This is a continuation of work previously reported (Mass. Expt. Sta. Bul. 441, p. 15, 1947). In attempting to determine the form of copper whose solubility was affected by unknown components of oat straw and alfalfa meal, it was found that the solubility of copper sulfide and copper phosphate, two prevalent forms of insoluble copper salts, was not increased by the soluble components of the crop residues. It is therefore inferred that the metallo-organic salts of copper, and not the inorganic salts, are the forms affected. Two papers have been published: "Extraction of copper from soil as affected by soluble components of oat straw and alfalfa meal," Soil Science Vol. 65, No. 3, March, 1948; and "Effect of decomposition of added oat straw and alfalfa meal on solubility of soil copper in ammonium acetate," Proceedings of the Soil Science Society of America, 1947.

Effect of Decomposition of Plant Residues on the Solubility of Soil Manganese. (Charles Hurwitz.) The results, entitled ' Effect of temperature of incubation of amended soil on exchangeable manganese", have been submitted to Soil Science for publication. The effect of the temperature of decomposition of oat straw and alfalfa meal on the solubility of soil manganese in Merrimac sandy loam was studied at 4° C., 14° C., 31° C., 37° C., and 47° C. Neither water-soluble nor easily reducible soil manganese was affected, but ammonium acetate-soluble manganese showed marked variations. Little change was observed at 4° C. and 14° C., but above 30° C. the ammonium acetate-soluble manganese increased as a logarithmic function of the temperature of incubation. After further incubation, the exchangeable manganese decreased to initial levels. There was a tendency for the increase to be maintained over a longer period at the higher incubation temperatures. Glucose and peptone, when added to soil instead of oat straw and alfalfa meal, also increased the ammonium acetate-soluble manganese, both the increase and subsequent decrease being more rapid. When no organic matter was added to the soil, no increase in soluble manganese was observed from 4° C. through 37° C. At 47° C. a slight but significant increase was observed.

These findings may prove important in the management of greenhouse and seed-bed soils where steam sterilization is used. Toxic concentrations of manganese may result from the sterilization temperatures. Oxidation of these toxic concentrations to insoluble forms may be delayed or may not occur because of the destruction of the manganese-oxidizing bacteria by heat.

DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Diseases of Trees in Massachusetts. (M. A. McKenzie, A. Vincent Osmun and D. H. Marsden.)

The Dutch Elm Disease Problem. The first discovery of the Dutch elm disease in Massachusetts was in 1941, when a tree in Alford, Berkshire County, was found to be infected by the causal fungus, *Ceratostomella ulmi* (Schwarz) Buisman. As of July 6, 1948, the disease fungus has been isolated from 1422 elm trees of 94 municipalities in 11 counties on the mainland of Massachusetts; Barnstable, Dukes, and Nantucket being reported as disease-free at present. Those towns with a relatively large population of weed elm trees are confronted with a difficult disease control problem; but where the number of elms is more restricted and the trees have received the care given valued trees, practical disease control should be possible. Three distinct zones of build-up in disease are apparent in the State. From the original outbreak, the disease has spread rather widely in Berkshire County. In the Connecticut Valley region, the increase in the number of diseased trees has been conspicuous in the last three years; and more recently in eastern Massachusetts, elms in the vicinity of Boston have been seriously affected. The spread of the disease from year to year is shown by the following table:

Year	Cumulative Totals		
	Trees	Towns	Counties
1941	1	1	1
1942	7	5	2
1943	11	6	2
1944	43	15	2
1945	85	24	3
1946	381	47	8
1947	1052	68	11
1948 (July 6)	1422	94	11

In studies to determine the spread, build-up, and possible benefits of combative measures, laboratory diagnosis of specimens is required for accurate determination of the causal fungus. The specimens are collected by scouts trained in the detection of characteristic symptoms on trees suspected of the disease. Diseased trees are reported to the Massachusetts Department of Agriculture and that Department carries out a cooperative disease control program with municipal governments or agencies responsible for affected trees. In a prepared schedule sanitation and other measures designed to restrict the spread of the disease are outlined for varying local conditions. These measures are presently under further study, including experiments in cooperation with the Department of Entomology on the use of spray materials for the control of bark beetles which serve as vectors of the disease fungus.

In general, the rate of increase in the number of diseased trees reported is most conspicuous in those areas where suppressive measures are lacking, poorly timed, or misapplied. Delay in the application of disease restrictive measures is costly, and expected benefits may be tragically nullified if essential work awaits a convenient assignment.

Thirteen progress reports (mimeographed) and six press releases were sent out during the year.

Cytospora Disease of Spruces. A common malady of ornamental spruces is a canker disease which attacks twigs and branches. In previous reports the cause of the disease was identified tentatively as the fungus *Cytospora Kunzei* Sacc. Lacking the identification of the causal fungus in its perfect stage on spruce, the disease was called, commonly, the "Cytospora disease" or "Cytospora canker."

In April 1947, a fungus identified as *Valsa Kunzei* Fr. was found associated with cankers on twigs and branches of Norway spruce and Colorado blue spruce. This fungus, believed to be the perfect stage of the aforementioned Cytospora, was described in detail, and a study was made of the growth and appearance on artificial culture media and on sterilized host tissue. Inoculations on young Norway spruce trees with *Valsa Kunzei* resulted in cankers and the death of some of the inoculated branches.

The Valsa stage may be involved in the natural spread of the disease by means of wind-blown ascospores, and further investigations into that possibility are needed. Also, a more intimate knowledge of factors predisposing spruces to the disease and avenues of host infection by the fungus are to be desired as prerequisites to an attempt to achieve effective control.

Other Tree Problems. Forty-eight diseases of twenty-three species of trees, including seven diseases of elm, were identified from more than 1500 specimens and inquiries received during the year. The Cephalosporium wilt of elm was reported from one additional municipality in the State. *Verticillium* sp. was isolated from several species of woody plants.

Winter injury to trees and to evergreens in particular was extensive this year. Later, during the extended period of wet weather at the time tender foliage was developing, conditions were ideal for infection of leaves by fungi. Elms, maples, sycamores, oaks, and ashes were among trees on which foliage was seriously affected and partially lost in early summer because of leaf diseases. Also, heavy infection of leaves by the black spot fungus indicates that additional loss of elm leaves may be expected by midsummer.

Two other tree disease problems have occasioned increasing numbers of inquiries in recent years. The death of individual branches and limbs in maples, leaving characteristic reddened or bronzed flags presents a problem which calls for study; and the dying of oaks lacks specific explanation. In limited studies, a combination of circumstances, including the preliminary weakening of the oaks by the defoliating gypsy moth, appears to be a logical explanation of the heavy mortality among these trees.

Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment. (W. L. Doran.) Work was continued on the effects of fungicides applied as powder-dips to cuttings immediately after treatment with a root-inducing substance, usually indolebutyric acid, applied by the solution-immersion method.

The following fungicides thus used were harmless to the cuttings of these species: Spergon (tetrachloro-parabenzoquinone) with Canada hemlock, *Genista pilosa,* and *Juniperus squamata Meyeri*; Phygon (2, 3-dichloro-1, 4 naphthoquinone) with Canada hemlock and *Genista pilosa;* morpholine thiuram disulfide with Carolina hemlock; zinc ethylene bisdithiocarbamate with red cedar; and a zinc dimethyl dithiocarbamate-cyclohexamine with Chinese juniper.

The use of the following fungicides similarly applied was followed by poorer rooting or apparent injury in the case of cuttings of these species: Arasan (tetramethyl thiuram disulfide) with Canada hemlock, heather, and *Genista pilosa*; Semesan Jr. (1.0% ethyl mercury phosphate) with Canada hemlock, Carolina hemlock and *Pachistima Canbyi*; Puraturf (6.0% phenyl mercury triethanol ammonium lactate) with Canada hemlock and creeping juniper; 2 percent Ceresan (2.0% ethyl mercury chloride) with Carolina hemlock and *Pachistima Canbyi*; zinc trichlorophenate with red cedar and *Pachistima Canbyi*; Fermate (ferric dimethyl dithiocarbamate) with heather.

It should be noted that here and throughout the report on this project better rooting means rooting in larger percentages or in a shorter time or with a larger root system.

In cooperation with Dr. Malcolm A. McKenzie of this Department, work was begun on the vegetative propagation of an elm, the Christine Buisman variety of *Ulmus carpinifolia*, which has been found to be resistant to the Dutch elm disease. Not more than 54 percent of the root-cuttings taken in early December lived more than 24 weeks after their insertion in sand, with proximal ends exposed, in a greenhouse bench; and the average length of the top growth made meanwhile was 4.5 inches. Root-cuttings taken in early March and similarly handled made root and top growth much more rapidly, with 95 percent of them living and rooted at the end of 59 days; and the average length of the top growth made meanwhile was 9.0 inches. Early March root-cuttings which were wholly covered, both distal and proximal ends under the sand, gave very inferior results.

Talc was compared with activated charcoal as a carrier of indolebutyric acid or naphthaleneacetic acid applied to cuttings by the powder-dip method. Talc so used gave better results than the charcoal with cuttings of English ivy, Hinoki cypress, bearberry, *Pyracantha coccinea*, *Ilex crenata*, *Picea glauca* and *Berberis Sargentiana*.

Taken in October, cuttings of American holly rooted equally well in sand and in flue-ash, but there was a better survival of cuttings of hemlock in sand than in flue-ash.

December cuttings of Canada hemlock rooted in larger percentages if made of wood in its first or second year rather than of wood in its third year. The rooting of cuttings of Carolina hemlock was much improved by indolebutyric acid 200 mg./l., 23 hours.

Cuttings of sugar maple rooted fairly well if taken in June and treated with indolebutyric acid but there was a high mortality among the rooted cuttings during the following winter in the greenhouse. Rooting of November cuttings of *Berberis Sargentiana* was hastened by indolebutyric acid 6 or 12 mg./gm. talc. Cuttings of *Rhododendron calendulaceum* taken in June rooted poorly without treatment, very well after instanteous-dip treatment with indolebutyric acid 5 mg./cc.

Two papers were written and published.[1]

Diseases of Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures. (W. L. Doran.) Fungicides were applied to soils in a carrier of commercial fertilizer (usually a 5-8-7 formula at the rate of 15.6 grams per square foot of soil surface) immediately before seeding. Their effects on the damping-off of several vegetables, on smut of onion (caused by

[1]Doran, W. L. and Beaumont, A. B. Vegetative propagation of kudzu. Jour. Amer. Soc. Agron. 39:9:834-835. 1947 (Mass. Agr. Expt. Sta. Contrib. No. 625).

Doran, W. L. Get out your knife and see how you can multiply. Horticulture 25:16:447, 461. 1947.

Urocystis cepulae Frost), on clubroot of cabbage (caused by *Plasmodiophora brassicae* Wor.), and on growth of plants are here summarized. Rates of application of the fungicides are in all cases expressed as grams per square foot, 1.0 gram per square foot being about 96 pounds per acre. None of the materials were injurious to plants unless it is so stated, and their use was often followed by an increase in average green weights of seedlings.

The result of the control of pre- and post-emergence damping-off is expressed as the percentage increase in number of living seedlings, the basis of comparison being the numbers of plants which lived in untreated soil. Numbers of living cabbage seedlings were increased 633 percent by Phygon (2, 3-dichloro-l, 4 naphthoquinone) 0.65 gm.; less by Arasan similarly used; and 377 percent in one case, 889 percent in another, by Tuads (tetramethyl thiuram disulfide) 0.65 gm. Increase in weight of cabbage seedlings was 86 percent with Phygon, 50 percent with Tuads. Numbers of tomato seedlings which lived were increased 281 percent by Tuads 0.65 gm., 246 by Phygon 0.65 gm. Increases in average green weights of the seedlings were 183 and 233 percent, respectively. The use of Tuads 0.65 gm. was followed by an increase of 35 percent in the number of living beet seedlings and 82 percent in the number of living lettuce seedlings.

With more than 50 percent of the onion seedlings infected with smut in untreated soil, Tuads 0.65 gm., Phygon 0.65 gm., or Fermate (ferric dimethyl dithio-carbamate) prevented all smut. Since Tuads and Phygon gave better control of damping-off than Fermate, larger numbers of plants survived, the increase over numbers surviving in untreated soil being more than 1000 percent with both materials. However, Phygon sometimes retarded the growth of onion seedlings slightly, so Tuads or Arasan (another tetramethyl thiuram disulfide product) is probably to be preferred. When 50 percent of the onion seedlings in untreated soil were infected with smut, there was no smut with Arasan 0.6 gm. and, as a result of good control of damping-off, numbers of living plants were greater by more than 2000 percent.

The organic fungicides used gave some degree of protection against clubroot of cabbage when it was not too severe in untreated soil, and the abstract of a paper on this phase of the subject has been published.[1] But with 100 percent severe infection in untreated and heavily watered soil, there was poor or little control of clubroot by Arasan 0.7 gm., Phygon 0.7 gm., Tuads 0.65 gm., or a zinc dimethyl dithiocarbamate-cyclohexylamine complex 2.0 gm.

With clubroot of cabbage severe, 100 percent infection in untreated soil, there was also 100 percent infection in soil to which hydrated lime 20 gm. had been applied and in soil to which mercurous chloride 0.2 gm., but no lime, had been applied. But when hydrated lime 20 gm. and mercurous chloride 0.2 gm. were applied together to this soil, there was only 13 percent clubroot, the degree of infection was slight, and the average green weight of the plants was 128 percent greater than in untreated soil. Mercurous chloride 0.2 gm. or mercuric chloride 0.1 gm. retarded the early growth of cabbage if applied to *unlimed* soil immediately before seeding, but not if applied to soil limed as described above. (This was true also of their effect on onion seedlings.) Neither of these mercury salts was injurious to cabbage plants if applied to soil 22 days before seeding.

The effect of soil-moisture content on the control of clubroot is now under investigation, with soil watered daily to 50, 65, and 80 percent of its water-holding capacity. Thirty-six days after seeding, there was 100 percent clubroot in the wettest soil, 56 percent in the soil 65 percent saturated, 10 percent in the dryest

---

[1]Doran, W. L. Fungicides applied in fertilizers for the control of cabbage clubroot and damping-off. (Abst.) Phytopathology 37:11:848. 1947.

soil, and no clubroot at any soil-moisture content in soil treated with both hydrated lime 20 gm. and mercurous chloride 0.2 gm.

Tobacco Frenching. (L. H. Jones.) Research this past year has been concerned with the effect of partial sterilization of the soil on the elimination of the frenching factor; with the control of frenching by adding iron to the soil and its relation to iron content of the foliage; and with the symptoms of frenching induced by nitrogen deficiency and soil temperature, separately or combined.

A compost soil was divided into four fractions for treatment by autoclaving, air-drying, or formaldehyde, with one portion left untreated as a check. Both soil temperatures, high 95° F. and low 70° F., were used. Nitrogen was frequently added to the soil and the diphenylamine test on the foliage always showed nitrates present in the plants. No frenching occurred at the low soil temperature of 70° F. or on the plants in the autoclaved soil at 95°F. Air-drying of the soil did not prevent frenching in this experiment although it had been effective in previous experiments. Formaldehyde was not a preventive, although the soil had been treated with four times the amount usually recommended.

That the organism, or frenching factor, does not enter the soil through fresh cow manure is indicated by the results of an experiment in which manure was mixed with autoclaved soil and the plants grown at 95° F. No frenching occurred. Frenching did occur when the manure was mixed with non-autoclaved soil and in the check soil receiving no manure. The nitrogen content of the plants was high in all tests.

Freezing the soil does not eliminate the frenching agent. Immediately after thawing, soil from a pile subjected to freezing all winter produced frenched plants in 7 days, whereas soil protected against freezing required 10 to 13 days.

Chemical analysis for iron in the above-ground portion of Havana Seed tobacco plants indicated a relationship between iron content of the plants and frenching. The iron content was much lower in plants grown at a soil temperature of 95° F., which frenched, than in plants grown at a soil temperature of 70°, which did not french. However, when the soil was autoclaved before the plants were set, no frenching occurred at 95°, and the iron content of the plants was even higher than that of plants in autoclaved soil at 70°.

The addition of a ferrous sulfate–peat mixture prevented frenching and gave the plants a very high iron content. However, when the iron was supplied from the less available iron of ferric phosphate mixed with peat, frenching was not prevented by three lessening amounts and the iron content of the plants was no greater than that of plants grown in soil to which no iron was added. The heaviest application, however, did prevent frenching and the plants were higher in iron content, containing an amount similar to that found in plants growing in autoclaved soil where frenching did not take place.

It has been reported frequently that frenching is due to nitrogen deficiency. During the year it has been established that the early symptoms of frenching, pinhead mottling, induced either by high soil-temperature or by nitrogen deficiency are so nearly alike that the one cannot be distinguished from the other by general observation. Study of the various steps in the onset of the diseaase has shown that the pinhead mottling induced by high soil-temperature appears at the tip of a young leaf, earlier leaves being a dark healthy green; while pinhead mottling due to nitrogen deficiency appears first on the side near the margin of a yellow-green leaf, stunted by lack of nitrogen, the earlier leaves being quite yellow and even fired. Succeeding leaves in both instances are so nearly alike that, unless on the plant, the cause would be sheer guesswork. Sometimes it is possible to use the diphenylamine test to distinguish the cause.

Both causes produce chlorotic, narrowing leaves, even to filiform. Rosetting also occurs. Frenching from high soil-temperature is usually obtainable within 20 days and has been obtained in as little as 5 days. In these experiments, the shortest time in which pinhead mottling was obtained from a nitrogen-deficient soil was 38 days.

Plants with frenching due to nitrogen deficiency have always resumed normal growth after the application of nitrogenous material to the soil, but affected leaves did not completely recover. Frenched plants resulting from a high soil-temperature do not respond to applications of nitrogen, but resume normal growth if the soil moisture is reduced so that the plants wilt, or if the soil temperature is reduced to about 70° F. Frenched plants with chlorotic leaves due to nitrogen deficiency remain chlorotic till nitrogen is supplied. On the other hand, the chlorosis resulting from a high soil-temperature frequently disappears and newly developing frenched leaves, even the filiform type, may develop with a normal green color.

The theory that a lack of available iron is the cause of the type of frenching induced by a high soil-temperature is further substantiated by an experience with chlorotic rose plants in a greenhouse. The temperature in the greenhouse was high (August). A manure mulch supplied ample nitrogen, which was verified by the diphenylamine test on foliage tissue. An application of a mixture of iron sulfate (copperas) and peat followed by a heavy watering brought recovery to the plants. Discs made from the chlorotic leaves and floated on a solution of ferrous sulfate (Fe 6 p.p.m.) recovered a normal green color, while the checks remained chlorotic.

Tomato Leaf Mold Caused by the Fungus Cladosporium fulvum Cke. (E. F. Guba, Waltham.) All the effort since the last report has been concerned with the further improvement of Improved Bay State tomato with respect to quality and yield of fruit and resistance to leaf mold. This tomato is essentially similar to the Bay State tomato described in Massachusetts Agricultural Experiment Station Bulletin 393, 1942, with the factor for resistance to all forms of the fungus *Cladosporium fulvum* Cke. added. The variant of the pathogene to which Bay State, Globelle, Vetomold-121, and Vetomold are highly susceptible does not trouble Improved Bay State, which is resistant to all forms of the pathogene and has been reported to be highly resistant wherever in the world it has been grown. This tomato is grown extensively under glass in Ontario, New York, Nova Scotia, and the New England States, and the financial benefit to growers has been great.

Similar resistance to *Cladosporium* has been bred into several English forcing tomatoes such as Carter's Sunrise, Kondine Red, Hundredfold, Best-of-All, and Market King. The study of these hybrids is in progress in the desire to develop a range of commercially acceptable resistant types.

Search for Inherent Resistance to Tomato Late Blight Fungus. (E. F. Guba, Waltham.) Approximately 200 types of tomatoes have been tested for their behavior to the late blight fungus, *Phytophthora infestans* (Mont.) de Bary. The tomatoes were grown to maturity in the field in the summer of 1947, but because of unfavorable weather conditions for the fungus it was not possible to promote the disease.

Growth and fruiting habits of the plants were recorded. Epidemic conditions for the fungus were established among stands of seedlings of these tomatoes in the greenhouse in the early season of 1948. Included in these tests were *Lycopersicum esculentum*, *pimpinellifolium*, *hirsutum*, *peruvianum*, and numerous plum, cherry, and currant fruiting types in red, orange, and yellow colors and plant

growth varying from extremely prostrate to erect. Most of these tomatoes are primitive and were obtained either directly from South America or through the Office of Foreign Plant Introduction, U. S. Department of Agriculture. From duplicated tests in the greenhouse, some promising types immune to the late blight fungus have been found. These represent survivals in the presence of complete devastation of the rest of the planting from the disease. These plants are being grown for seed and further study before undertaking a contemplated breeding program.

Causes and Control of Decay of Squash in Storage. (E. F. Guba, Waltham.) The objective was to learn the value of fungicidal protectant treatments in the field in relation to squash keeping. A field of squash was maintained and sprayed during the summer months. In addition, the squash were immersed in fungicides after harvest and checked periodically for infection during the winter storage season. Careful records of yields and disease were maintained.

Black Rot, caused by the fungus *Mycosphaerella citrullina* (C.O.Sm.) Gross, was unusually destructive on Butternut and Hubbard squash. Unusually warm weather up to December was an important factor contributing to the losses in storage. In the field the disease was best controlled with Fermate which yielded 3.2 percent infected squash; Parzate, 2.8 percent; and Zerlate, 1.7 percent. Unsprayed plots averaged 31 percent infected squash.

The successful control of Black Rot of Butternut squash in storage requires protectant spraying with fungicides in the field. Dipping the squash at harvest in Parzate, Phygon, or Zerlate suspensions controlled Black Rot well only when the squash had been sprayed in the field. When the stem end was removed, stem end infection was as prevalent as side infection. When the stems were retained, there was less disease at the stem end than on the sides. Painting the stem end with Phygon or Zerlate greatly reduced stem end infection, especially among squash from plots sprayed with fungicides in the field. The results show the possibilities of reducing Black Rot in storage by protectant field spraying and disinfestation of the squash with fungicides prior to storage.

Resistance to Fursarium dianthi Prill et Del., the Cause of a Serious Carnation Wilt Disease. (E. F. Guba, Waltham.) Considerable hybridizing has been done, and seedlings have been grown from successful crosses. Some 75 promising seedlings have been propagated from cuttings during the winter of 1947-48. These have been placed with two growers, recommended by the New England Carnation Growers Association, for further judging, and any that are acceptable will be subjected to tests to determine their reaction to disease, and notably to Fusarium Branch Rot.

Investigations of Fungicides which Promise Value in Apple Disease Control. (E. F. Guba, Waltham.) The objective implied by the original title of this project, i.e. "Interrelation of Wettable Sulfur, Lead Arsenate and Lime in Apple Spraying", has been attained. Project now is designed to acquaint growers with the advantages and limitations of new materials as protectants and eradicants for scab.

Lime or clay appeared to depreciate the fungicidal value of Puratized Agricultural Spray. Fermate or high grade wettable sulfur added to Puratized Agricultural Spray can be beneficial. Both Phygon and Flotation Sulfur Paste gave excellent scab control. Phygon causes a serious chlorosis of the foliage which appears to be corrected satisfactorily by the addition of twice as much Epsom salt. Epsom salt added to the spray produced darker green foliage.

The eradication of scab with Puratized Agricultural Spray was again incomplete in 1947 and 1948. Used as a protectant spray, it has given very good scab control on McIntosh trees. The fungicidal action of this spray residue deposited on glass slides is lost after 24 to 48 hours, indicating decomposition and the volatile nature of the active principle.

Scab eradication in 1948 was outstanding and striking with phenyl-mercuri acetate (Fungicide No. H L 331, California Spray Chemical Corp.); phenyl mercuri monoethanol ammonium acetate (Puratized B); and phenyl mercuri formamide (Puratized 806) (Gallowhur Chemical Corp.). The striking fungicidal action of these mercury sprays upon visible and incubating scab infection suggests that satisfactory control of this disease is possible with a belated and curtailed schedule of applications.

Miscellaneous Studies. (E. F. Guba, Waltham.)

Control of Seed Decay and Damping-off of Vegetable Seedlings by Seed-borne Chemicals. The tests of this year have concluded the effort to determine the best chemicals for the various kinds of vegetable seeds. Cuprous oxide, Semesan, Arasan, Spergon, and Phygon have general use; and Semesan, Jr., Fermate, and Zinc Oxide, special and limited application. Information is offered to the vegetable industry in the Vegetable Seed Treatment Chart published by the Extension Service of the University.

Contact Dermatitis Among Celery Farmers. Coincident with the introduction of green Summer Pascal celery, many farmers have complained about dermatitis on the hands and forearms from contact with this celery. Sensitive workers develop dermatitis especially while harvesting and stripping celery in the field, and contact with rotted and ripe celery is especially hazardous. Spoilage of celery in the field is due to the bacterial soft rot organism *Erwinia carotovorus*. On an average, one-third of the white workers are infected. Colored workers from the Bahama Islands and Jamaica are not sensitive. Numerous celery growers were tested for sensitivity with healthy and rotted celery tissue, with dextro-limonene oil extract of healthy stalks and leaves taken up in 9 parts of persic acid, and with crude oil from stalks and leaves without dilution. Workers sensitive to celery dermatitis in experimental tests gave positive reactions as indicated by erythema, pruritis, ulceration, vesicles, induration, and maculopapular lesions. The injurious factor is ascribed to dextro-limonene, the oil in the celery.

This study was conducted in cooperation with Dr. John G. Wiswell, Dr. John W. Erwin, Dr. Francis W. Rackemann, and Miss Lena L. Neri of the Massachusetts General Hospital, Boston. Some phases of the study require further research for completeness.

A report of the study has been accepted for publication by the American Journal of Allergy.

DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

Factors Affecting the Vitamin Content of Milk and Milk Products. (Arthur D. Holmes.) The two types of milk, cows' and mares', used in the four studies that were completed during the past year were produced on the University farm under normal conditions. With one exception, i.e., milk from a Palomino mare, all the mares' milk was obtained from young Percheron mares. The cows' milk

was mixed herd milk produced by the five dairy breeds of cows included in the University herd.

Composition of Mares' Milk as Compared with that of Other Species. (Arthur D. Holmes, Albert F. Spelman, C. Tyson Smith, and John W. Kuzmeski.) The mares' milk used in this study was produced by a Palomino and four Percheron mares. All were mature, well-developed, normal animals, four to ten years old, and in their first or fifth lactations. The study was made in the spring and 26 samples of milk were assayed. The average values obtained for the milk of Percheron mares were: water 89.7 percent; protein 2.3 percent; reduced ascorbic acid 89 mg. per liter; phosphorus 63 mg., potassium 64 mg., magnesium 9.0 mg., and calcium 102 mg. per 100 g. These values indicate that mares' milk contains more water than cow, goat, ewe, buffalo, camel, or human milk; less protein than cow, goat, ewe, buffalo, or camel milk, but more than human milk; more ascorbic acid than cow, goat, or human milk; less phosphorus than cow or goat milk but more than human milk; only about one-third as much potassium as cow or goat milk; and less magnesium and calcium than cow or goat milk, but four times as much calcium as human milk. The ratio of calcium and phosphorus is considerably higher in mares' milk than in cows' or goats' milk but possibly lower than in human milk.

Apparently this paper was of service to people in widespread areas, for the numerous requests for reprints rapidly exhausted the available supply.

Stability of Reduced Ascorbic Acid in Mares' Milk. (Arthur D. Holmes and Carleton P. Jones.) The milk was produced by mature Percheron mares at the end of the lactation period. The samples were collected late in the fall and pastures provided nearly all of the forage for the mares, but since the season was warm and sunny, the rainfall ample, and the pasture had been closely grazed, the grass was young and green.

Fifteen samples of mares' milk with initial potencies of from 86 to 161 mg. of reduced ascorbic acid per liter were stored in the dark at 10°C. They were assayed at daily or longer intervals. Four samples observed for 10 days lost an average of 2.5 mg. per liter daily; four samples stored 20 days lost 1.8 mg. per day; two stored 28 days lost 1.3 mg. daily; and three stored for 33 days lost 1.1 mg. per liter per day. These data show that the rate of loss of reduced ascorbic acid from mares' milk is only a fraction of the rate of loss from cows' milk.

Some Characteristics of Mares' Colostrum and Milk. (Arthur D. Holmes and Harry G. Lindquist). Assays were made daily of the colostrum and early lactation milk produced by one Palomino and three Percheron mares. The experimental period was of fifteen days' duration for the Palomino and twenty-one days for the Percherons. The pH value of the colostrum was very stable for the first four days; on the fifth day it was decidedly higher; and from the fifth to the twenty-first days it was quite constant. The fat content of the colostrum averaged 2.5 percent for the first four days of lactation; from the fifth day it decreased slowly during the remainder of the experimental period. The quantity of total solids in the colostrum decreased very rapidly during the first two days and thereafter decreased slowly. The reduced ascorbic acid was relatively low in the colostrum but increased fairly steadily from the first to the sixteenth day of lactation and then decreased somewhat. At the first estrual period, which ordinarily occurs about nine days postpartum, both the fat and ascorbic acid content of the milk changed from the values obtained before or after the estrual period. All the mares were bred at the first estrus. The foals of the two mares that were bred late in the estrual period developed diarrhea, a condition which is not uncommon for the first postpartum estrus of mares.

Permanency of Synthetic Ascorbic Acid Added to Milk. (Arthur D. Holmes and Carleton P. Jones.) In a study of the stability of ascorbic acid in mares' milk, Holmes and Jones found the rate of disappearance of ascorbic acid from mares' milk was only about one-seventh that reported by Hand for cows' milk. Mares' milk contains several times as much ascorbic acid as is found in cows' milk. Accordingly a study was made of the rate of loss of reduced ascorbic acid from cows' milk to which a sufficient amount of synthetic ascorbic acid had been added so that the ascorbic acid content of the milk approximated that of mares' milk.

Two series of 20 samples each were prepared by adding 75 mg. or 150 mg. of ascorbic acid to a liter of raw cow's milk. The samples were stored in 500-cc. flasks in the dark at 10°C. As aliquots were removed day by day for analysis, the volume of milk decreased and the volume of air in the flasks increased correspondingly. For the series of samples of milk to which 75 mg. of ascorbic acid per l. was added, the loss was 11 percent per day for the first 3 days and 5 percent per day for the remaining 7 days, or 7 percent per day for the entire period. For the series of samples of milk to which 150 mg. of ascorbic acid per l. was added, the loss was 6 percent per day for the first 4 days and 1 percent per day for the remaining 6 days, or an average of 3 percent per day for the 10 days of storage.

A Study of the Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables Used for Home Consumption. (Arthur D. Holmes.) The investigations conducted on this project during the past fiscal year were confined to two vegetables, tomatoes and squashes, that were grown on the University farm under controlled experimental conditions. Assays were made of typical specimens to determine the extent that cultural conditions or varieties affected the nutritive value of the vegetables under investigation.

Variation in Composition of Winter Squashes. (Arthur D. Holmes, C. Tyson Smith, and William H. Lachman.) Assays of the edible portion of five varieties of squash commonly used in this area as a winter vegetable showed considerable variation. Blue Hubbard was not as rich in carotene, phosphorus, and potassium as Butternut and Golden Cushaw, which are relatively new varieties that are gaining popularity. The Buttercup squash, which is frequently referred to as "a dry squash," contained less water and more reducing sugars than any of the other varieties. The Butternut was very rich in carotene, phosphorus, and potassium. Des Moines contained the smallest amount of carotene and ascorbic acid but the largest amount of calcium and magnesium of any of the varieties. Golden Cushaw was rich in carotene and contained the most protein, phosphorus, and potassium of any of the varieties included in this study. The results of the assays show considerable variation in the composition of the different varieties of winter squashes and of the different squashes within the varieties even though all were grown under uniform soil, fertilizer, and climatic conditions.

Effect of Different Mulches upon the Nutritive Value of Tomatoes. (Arthur D. Holmes, C. Tyson Smith, Charles Rogers and William H. Lachman.) An experiment of 6 years' duration was made to determine the possible effect of mulching upon the composition of tomatoes. A standardized Rutgers-Stokes strain of tomatoes was used. Plots with comparable soil were selected for three mulch treatments and a check, with two replicates of each. Four-inch layers of three types of mulch—horse manure with shavings, rye straw, and Servall (shredded sugar cane stalks)—were spread on the experimental plots as soon as the tomato plants were set out. During the past year, the sixth of the experiment, 12 samples

of 12 mature tomatoes each were assayed. The water, total solids, total sugars, and ascorbic acid contents of the tomatoes were similar for the check and the mulched plots. The tomatoes from the mulched plots contained more soluble solids and carotene than those from the check plots. Larger amounts of calcium, magnesium, phosphorus, and potassium were found in mulch-plot tomatoes than in the control-plot tomatoes. Judged by the results noted above, mulching tomatoes increases the mineral, especially phosphorus and potassium, content of the tomatoes.

Studies on the Quantitative Estimation of Hemicelluloses. (Emmett Bennett.) The data reported in the Annual Report for 1946-47 under this heading are published in the Journal of Analytical Chemistry.

Quantitative chemical procedures based on the removal of hemicellulose from holocellulose have received further consideration. Approaches have included (1) a study of the effects of acid hydrolysis, using different concentrations of acids, (2) alkaline extractions at different pH levels, and (3) means to determine when the holocellulose residue is substantially uniform, although possibly still retaining a quantity of furfural-yielding components. Results from the first and third approaches were of most promise. Limited data indicate that a slight increase in the concentration of the acid is more effective in bringing about hydrolysis than an increase in length of time. When plotted, these data also indicate that extraction is continuous. These observations would indicate that the whole cellulosic structure is attacked to some extent during the entire period of hydrolysis.

The alkali lability test, when applied to a holocellulose from which the hemicelluloses have been removed, yields an alkali number ranging from 0 to 3; before the hemicelluloses are removed by alkali, the number is of the order of 14. It would therefore seem possible to use the alkali number as a guide in determining approximately the time at which the incrusting hemicelluloses have been removed. The cellulosic residue is apparently not attacked appreciably by reagents used in this test.

The Chemical Investigations of Hemicelluloses. (Emmett Bennett.) Investigations dealing with the chemistry of hemicelluloses have been continued, with special attention to the hemicelluloses of corn stalks. Four different fractions when hydrolyzed yielded approximately 55, 68, 75, and 77 percent of reducing sugar as xylose. Specific rotations were all negative and had the values 40°, 46°, 34°, and 30°. Xylose appeared to be present in all fractions.

Quantitative estimations of xylose as the dibenzylidene dimethyl acetal did not prove successful and further work has been discontinued for the time. A good quantitative procedure for xylose would be very desirable. Because of certain disadvantages in the use of as-diphenylhydrazine for the determination of arabinose, attempts were made to utilize benzyl phenylhydrazine. The procedure, while fairly accurate for certain mixtures, was found to be unsuitable for general use.

Two of the fractions noted above yielded positive tests for starch, while two were negative. In each case the starch-like substance could be removed by treatment with a polidase-S enzyme preparation. Whether the presence of starch has a bearing on the origin of the pentoses is still an open question.

Results obtained thus far seem to indicate that fractions may differ qualitatively as well as quantitatively. In general, however, the fraction most resistant to extraction is likely to be the purest and the most homogeneous in character.

A report on the hemicelluloses of maize cobs and rye straw may be found in the Journal of Agricultural Research 75: 43-47 (1947).

The Investigation of Agricultural Waste Products. I. The Chemical Investigation of Lignin. (Emmett Bennett.) Attempts to increase the nitrogen content of lignin have been continued. Lignin was again oxidized by pure oxygen in a medium of concentrated ammonium hydroxide. It is known that organic compounds of phenolic nature absorb oxygen when dissolved in an alkaline solution. Ammonification appeared to take place simultaneously with oxidation. A maximum of over 8 percent of total nitrogen was obtained by oxidation for a period of 144 hours. The amounts of nitrogen combined, however, were not entirely proportional to the length of time of oxidation. The amount of ammoniacal nitrogen was approximately 34 percent of the total in all cases. This amount of nitrogen, which appears to be about the maximum attainable under the conditions, supports an hypothesis regarding the chemical structure of lignin.

In order to determine the extent to which changes were made during oxidation, the alkali lability test was used. Oxidations in this case were brought about in 0.2N sodium hydroxide. While it is doubtful whether a significant increase in the alkali number was obtained by oxidation for different intervals of time in sodium hydroxide, the number was significantly higher than that for samples oxidized in ammonium hydroxide.

That the size of the alkali number is, to a considerable extent, a function of the phenolic groups may be seen from the fact that when lignin is methylated, the alkali number becomes nearly zero. Furthermore the fixation of nitrogen seems to be dependent upon the hydroxyl groups, since nitrogen does not appear to be fixed to any extent in methylated lignin by oxidation with pure oxygen in concentrated ammonium hydroxide.

These data would tend to indicate that the formation of humus from lignin in the soil could be brought about by changes occurring in the hydroxyl groups.

THE CRANBERRY STATION
East Wareham, Massachusetts

H. J. Franklin in Charge

Administration. As provided by the legislature, a cranberry extension specialist was added to the official staff at the Cranberry Station in October, 1947, Mr. J. Richard Beattie, County Agricultural Agent of the Plymouth County Extension Service, taking this position. He will have over-all charge of the cranberry extension work in all Massachusetts counties interested in the cultivation of this fruit.

General. Severe drouth with high temperatures and excessive sunshine in August did much to curtail the 1947 Massachusetts cranberry crop and depreciate its condition. This and record high temperatures in October were very harmful to a satisfactory marketing of the fresh fruit.

The general terminal fall and winter budding of cranberry vines in Massachusetts in preparation for the 1948 crop was conspicuously good, in very marked contrast to that of the previous year which was notably poor.

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.) The second part of the work on cranberry insects—that dealing with pests not worm-like and attacking mainly the cranberry foliage and fruit—was finished and presented for publication. The insect and disease control chart was revised and brought up to date.

Chlorinated camphene, used both as a dust and as a spray, proved to be a fairly effective control for gypsy moth caterpillars.

Prevalence of Cranberry Insects in the Season of 1947*:*

1. Black-headed fireworm clearly more troublesome than usual in both broods.

2. Gypsy moth caterpillars practically absent on the bogs in the eastern part of Barnstable County, as in 1945 and 1946. As this area was very heavily infested with this pest every year for a good many years before 1945, it is believed by some that the egg masses of the insect were killed by the penetrating salty spray driven by the 1944 hurricane.

The 1947 gypsy moth infestation in Plymouth County and the western part of Barnstable County considerable, probably about average.

3. False armyworm, spotted fireworm (*Cacoecia*), and firebeetle (*Cryptocephalus*) infestations light or absent.

4. Cranberry sawfly caterpillars much more generally abundant than usual.

5. Fruitworm infestations spotty, but about normal on the average; much more troublesome than in 1945 and 1946.

6. Cranberry weevil and spittle insect much more abundant than usual on the Outer Cape, causing much concern there.

7. Red mites (*Paratetranychus*) more harmful on cranberry bogs than for many years.

8. Black cutworms on some bogs after removal of grub-control flood, but did less harm than usual.

9. Honeybees and especially bumblebees abundant on the bogs everywhere, though rather less so than in 1946.

Weather Studies. (H. J. Franklin and C. E. Cross.) Continuing interest in cranberry weather relations prompted further study, the results of which were prepared for publication as a supplement to Bulletin 433 of this Station. Important new information was obtained, that relating to the effects of the weather on the condition of the fruit having special value.

Frost Forecasts. (H. J. Franklin.) This special service was continued. Over 8000 acres of bog in the hands of 213 subscribers were covered by the telephone warnings, this being nearly four-fifths of the cranberry acreage with fair to full flowage protection. An accessory warning service by radio, in cooperation as heretofore with the United States Weather Bureau office at Logan Airport, was handled through Station WEEI at Boston.

Bibliography of Cranberry Literature. (H. J. Franklin.) From time to time, work has been done on a bibliography of cranberry literature. Cranberry literature has been carefully checked up to 1935, and about 1500 references have been made on 3 x 5 cards. The first reference found was in 1808. References were not numerous until about 1915, but since then there have been 25 or more a year. The literature from 1935 on is now being checked. When brought up to date, the bibliography will probably have over 2000 references, which it is planned to arrange by subjects. Any information on references to cranberries occurring in scientific journals where cranberry literature is not regularly published would be appreciated.

Control of Cranberry Bog Weeds. (C. E. Cross.) Since grasses, sedges, and rushes continue to be the chief weed problems of cranberry growers, efforts have been made to extend the season in which oils can be used selectively in the treatment of these weeds. The first two weeks of May continue to be the safest time for the treatment of weeds with both kerosene and Stoddard Solvent. Frost flooding of the bogs and rainy weather during these two weeks usually prevent the accomplishment of all the oil work projected on weedy bogs.

It is unsafe to spray Stoddard Solvent, even at the rate of 200 gallons per acre, after the terminal buds of cranberry vines have opened. Weather conditions at the time of spraying do not affect the results of spraying late in May—any new growth touched with this oil is seriously injured, though last year's leaves and stems may not be hurt. Any work in late May or early June with Stoddard Solvent must be done as an individual weed treatment, the oil being applied to the base of the weed only and kept from contact with any new growth on the cranberry vines.

Stoddard Solvent at 200 gallons per acre will kill asters, white violets, several species of Panicum, and numerous sedges and rushes. Experiments on a great variety of weeds are being continued.

Studies of the weather in relation to kerosene spraying have been made and lead to the following conclusions:

1. It is far more important that the bog be dry prior to oil treatment than that it remain dry afterward. Many grasses, sedges, and rushes die readily if dry when sprayed, even though rain falls immediately after treatment. The same types of weeds die after kerosene treatment even if the bog is flooded four hours afterward.

2. If cranberry vines have made some new growth, kerosene sprays can apparently still be used without vine injury if the shelter air temperature is 60°F. or lower. In some instances no injury occurred from kerosene spraying on vines with one inch of new growth when the temperature was 70°F. Too little is still known of the effect of humidity, sunshine, and wind velocity on the toxicity of oil sprays; but at present cool, cloudy, and windy days appear preferable to warm, bright, and calm days for late kerosene treatments.

Paradichlorobenzene was dissolved in kerosene and sprayed on cranberry vines and weeds. The addition of PDB does not add appreciably to the weed-killing properties of kerosene, the material dissolves only after excessive agitation, and the solution is very harmful to new growth on cranberry vines.

Further trials with paradichlorobenzene applied to cranberry bogs under one inch of sand indicate that the kill of small bramble (Rubus) and three-square grass (Scirpus) is inadequate to warrant the treatment. However, both spring and fall treatments using 7½ pounds of PDB per square rod under one inch of sand when wild bean is dormant appear to give nearly complete control of this weed.

When PDB is used under sand in new plantings, the cranberry vines develop so slowly that this treatment is not recommended.

Exhaustive tests of isopropyl phenyl carbamate failed to show any use for this material in cranberry weed control.

Winterkilling Studies. (C. E. Cross.) Experiments during the last two winters have shown that a single layer of 8-ounce burlap is sufficient to prevent the winter-killing of cranberry vines. The same is true of rough cotton cloth such as is used in the making of 100-pound sacks. Two thicknesses of tobacco netting did not give adequate protection to the cranberry vines. Substantially more cranberries were harvested from areas covered with cotton and burlap than from unprotected areas.

Frost Experiments. (C. E. Cross.) Burlap and cotton cloth were used on bogs to determine what degree of frost protection they would afford as covers over cranberry vines. Temperatures on frosty nights ranged from 4 to 8 degrees F. warmer under the coverings—the more severe the frost, the greater the protection. Paper was tried as a cheaper material. Though it apparently afforded good protection from low temperatures, it could not be anchored even in light winds, and is therefore considered impractical.

Soil Water Studies. (F. B. Chandler.) Studies of soil water made with wells and with tensiometers (instruments to measure the tension required to move water in the soil) show that one section of a bog is not uniform in water movement for drainage or irrigation. Some bog sections or parts of sections may be poorly irrigated although the ditches are filled with water. During the coming year, several growers are cooperating and more data will be available later.

Fertilizer Requirements of Cranberry Plants. (F. B. Chandler and William G. Colby.) The plots previously started have been continued and about 100 new plots added, for the purpose of studying the different sources of nitrogen (nitrate of soda, sulfate of ammonia, cyanamid, Urea-form and tankage), sources of phosphorus (rock phosphate, normal superphosphate, and triple superphosphate), amounts of nitrogen per acre (10, 20, 40, and 80 pounds of nitrogen per acre), and ratio of nitrogen to phosphorus (1-1 and 1-2.) Time of application and minor elements are also being studied. The results so far do not justify any recommendations.

DEPARTMENT OF DAIRY INDUSTRY

D. J. Hankinson in Charge

Sanitizing Agents for Dairy Use. (W. S. Mueller.) The newer sanitizing agents for dairy use have in common a quaternary ammonium salt of one form or another which is the active bactericidal material. A new development is a cleaner-sanitizer combination. These new products are now available in both liquid and powder form.

Some of the results of this study, "Testing Quaternary Ammonium Sanitizers and Their Use in the Dairy Industry" were published in *Soap and Sanitary Chemicals*, September, 1947 issue.

The following progress has been made:

1. *A Method for Evaluating the Sanitizing Efficiency of Quaternary Ammonium Compounds and Other Germicides Proposed for Sanitizing Food Utensils.* (W. S. Mueller and E. P. Larkin.) The method is described in the last annual report. During the past year more data have been obtained on several technical steps, for the purpose of improving the standardization of the suspension of test organisms as used in the test. A hand homogenizer was used for breaking up clumps of bacteria in suspension. A spectrophotometer was used for measuring the turbidity of the bacterial suspension and this value was correlated with the number of bacteria present as determined by the plate count. Three distinct types of bacteria were used in the study: a gram-negative organism, *E. coli*; a gram-positive organism, *S. aureus*; and a sporeformer, *B. cereus*. The different organisms were variously affected by homogenization. The plate count of *S. aureus* was increased 70 percent; that of *B. cereus* was slightly decreased. No significant effect was noted on *E. coli*.

Curves plotted for each of the three organisms show the relationship between the plate count and turbidity value as measured by the spectrophotometer. Results indicate that suspensions of non-sporeforming organisms can be standardized to a reasonably accurate number by the use of transmission curves. Results with *B. cereus* were doubtful; therefore standardization of spore suspensions by the use of the homogenizer and spectrophotometer cannot be recommended at the present time.

2. *New Developments in Sanitizing Teat Cups Between Cows Milked.* (W. S. Mueller and D. B. Seeley.) The method commonly used today for sanitizing teat cups between cows milked is ineffective because contact with the germicide is too short. This is a major cause for the spread of mastitis from an infected to a non-infected udder.

As a result of this study, a new method for sanitizing teat cups has been developed, in which the basic idea is the use of an extra milking-head assembly, thus making it possible to keep the teat cups in the germicidal solution for two minutes or more without increasing the milking time for the herd. This markedly reduced the total bacterial counts of the teat cup and under laboratory conditions killed almost all of the *S. agalactiae* organisms, which are chiefly responsible for mastitis due to infection.

From this study it is concluded that the new method of sanitizing teat cups between cows milked greatly reduces the chance of spreading mastitis through the herd, without increasing milking time or interfering with barn routine.

3. *Effect of Some Water Constituents on Quaternaries.* (W. S. Mueller and D. B. Seeley.) While "hard waters" have been reported to be incompatible with quaternaries, it seemed desirable to have more information on the effect of each of the many constituents normally found in potable waters. The germicidal potency of an alkyl-dimethyl-benzyl-ammonium chloride was tested against *E. coli*, and the tentative conclusions are as follows:

a. There was no direct correlation between water hardness as measured by the soap method and the germicidal potency of the quaternary solution.

b. The following ions had no adverse effect on the germicidal potency of the quaternary: cations—potassium, sodium, and lithium; anions—chloride, sulfates, and nitrates.

c. The following cations when present in sufficient quantities reduced the effectiveness of the quaternary: calcium, magnesium, and bivalent and trivalent ionized iron. Calcium and magnesium acted alike; trivalent ionized iron was far more detrimental than bivalent ionized iron.

d. A 200 p.p.m. solution of the quaternary studied had sufficient germicidal potency to do most sanitizing jobs even when the concentration of calcium plus magnesium was as much as 600 p.p.m.

e. A 200 p.p.m. solution of the quaternary was completely inactivated by 10 p.p.m. of trivalent ionized iron.

DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

Transfer of Ownership and Its Effect on Agricultural Land Utilization. (David Rozman.) Work on this project has proceeded with the examination of records obtained in agricultural communities in several parts of the State. The Registry of Deeds and assessors' records have provided the basis for a complete list of land transfers in the selected areas, from the beginning of 1940. The towns

studied during the past year were New Braintree in Worcester County, Amherst in Hampshire County, and West Newbury in Essex County. The study involves ascertaining present as well as former uses of each individual property. Further information is obtained from the records of the Agricultural Conservation Service so far as they are available. For the years already examined and analyzed, the following preliminary data indicate the changes occurring in agricultural land use and ownership.

There has been a continuous increase in the number of transactions affecting agricultural land throughout the period, reaching greatest intensity in the immediate postwar year. The number of transactions in the three towns under consideration increased from 32 in 1940 to 69 in 1946; and the number of acres involved, from 858 to 2700. In most cases the type of land use has shown a change under new ownership in both the prewar and the postwar periods. In 1940, out of a total of 32 transfers, only 13 farm units retained their former use; and in 1946, only 19 out of 69. Some of the farming units lost their identity after transfer and became part of a larger farming unit.

Changes from part-time farming into full-time farming or the reverse occurred in about equal numbers, both in the prewar period and in 1946. On the basis of incomplete preliminary figures, it appears that the movement of farm land into non-farming use is somewhat greater than the reverse movement of non-farm land into farms.

As a part of the study of the general trend in Massachusetts agriculture, an agricultural production program for 1948 was worked out and published in mimeographed form.

DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

Investigation of Materials Which Promise Value in Insect Control. (A. I. Bourne, W. D. Whitcomb, W. J. Garland, and C. S. Hood.) In the cooperative experiment with the Dow Chemical Company, dormant application of experimental materials D-289 and D-542 on apple killed overwintered eggs of apple aphids. Unsprayed trees in the test block showed 2050 aphids per 50 buds, with some buds showing as many as 105 plant lice; while on sprayed trees only an occasional bud showed a single aphid. No retardation in seasonal development resulted from either material.

Dormant application of D-289 and D-542 on sweet cherries practically eliminated black cherry aphis for the season. For the first time since this block had been set out, the trees were practically free from the evidence of this pest. No further steps were taken to control aphids in this block during the entire season, in contrast to previous years when several sprays of nicotine sulfate had been applied each year in an unsuccessful effort to check this pest.

Dormant application of D-289 and D-542 in the variety pear block gave very good control of pear psylla, although protracted cold windy weather so prolonged the appearance of adult psyllas that the dormant application was not quite so effective as in 1946 when more normal weather prevailed.

Laboratory tests of D-289 on egg masses of eastern tent caterpillar showed promising reduction in numbers of emerging larvae. The light infestation in this area made it impossible to operate on any large scale. Results were sufficiently good to warrant further study in a season of greater attack.

B-542 in dormant application on cultivated blueberries gave striking control of a very troublesome species of Lecanium (*L. quercifex*). Results with this material were so nearly perfect that we hope to spray the entire blueberry plantings in college plots and eradicate this potentially serious pest. This is one of the first successful attempts to control this pest on blueberries.

At Waltham, experimental applications of new materials for the control of summer infestations of the European red mite were made on August 13 and 18, 1947, where the average infestation was 4 to 6 mites per leaf. Counts of 60 leaves per treatment 10 to 14 days later showed excellent control from all materials, as follows:

Code Number	Formula	Dosage (per 100 gallons)	Reduction of Mites per Leaf (percent)
C-740	Chlorophenyl ethane and DDT	2 quarts	98.8
C-714	Chlorophenyl ethane	1 pint	97.7
+C-726	Chlorophenyl methane	20 ounces	
D-111	Dinitro ortho cresol	16 ounces	96.8
Check	None		5.2

Abnormally high temperatures and prolonged drouth occurred in the period covered by this experiment, and C-740 caused moderate foliage injury under these conditions.

Insecticides for the Control of the European Corn Borer. (A. I. Bourne.) The first brood infestation in general was comparatively light, although some fields in well-protected areas in the lower Connecticut Valley showed considerable damage. The second brood was more serious, and many late plantings which were untreated suffered severe damage. Cold wet weather in May retarded pupation, which, for the most part, took place at irregular intervals following an occasional warm day. Moth emergence was correspondingly delayed and the first eggs were observed about June 10. First hatching was noted about mid-June.

Growth of corn was somewhat retarded by the same weather conditions. In some fields planted April 29, the plants were just breaking ground by mid-May and only reached a height of 3-4 inches during the warm period in the closing days of the month. Cool weather during most of June did not improve conditions greatly. Very hot weather in the last days of June and through July, however, stimulated rapid growth and the earliest planted fields were ready for harvest by about July 25.

Corn borer damage in the experimental plots was not severe even in untreated plots, where the average from all pickings was 85 percent clean corn compared with an average of 98 percent clean corn in treated plots. However, in the check plots only 75 percent of the yield was of marketable grade, and the total yield averaged 35 percent more marketable ears in the sprayed plots than in the check plots. The heaviest yield was on the Derris and Ryanex plots, which averaged 42.4 percent more ears of marketable grade than the unsprayed check plots, indicating that, even with a moderate infestation, feeding of the larvae lowered the vitality of the plants enough to cause not only a reduction in total yield but an even more serious reduction in ears of marketable quality.

Potato Spraying Experiments. (A. I. Bourne.) Potatoes were planted on May 12. May was slightly cooler than normal, with slightly more precipitation than usual, well distributed over the month as light rains except for two storms on the

3d and 25th. Cold weather somewhat retarded the first appearance of the plants, but once they broke ground they made steady and satisfactory growth. June also was slightly cooler and rainfall slightly less than usual. Growth was somewhat slow but was not seriously interrupted. The balance of the growing season was warm and very dry. The location of the experimental plots in rather a low area and on heavy soil prevented serious retardation, and the plants progressed very well and matured a good crop.

No spray injury was noted at any time during the season except a possible trace following calcium arsenate. The plants showed a tendency to ripen slightly earlier than usual but many were alive until the heavy killing frost in late September. This was very noticeable on the DDT plots, which remained green right up to frost.

Early flea beetle attack was comparatively negligible, but by late July the second brood appeared in some size and continued to mid-August. A moderate infestation of plant lice appeared in early August. Aphids were in moderate abundance through all plots except those given DDT emulsion, where only a few appeared.

Fifteen applications were made at weekly intervals from June 12 to September 17 to protect all new growth from attack. At least three extra applications were made to furnish protection in case of the recurrence of blight, which caused such havoc to tomatoes and potatoes in 1946. By mid-August the plants in the Bordeaux-sprayed plots began to show less vigor and considerable scarring from flea beetle attack. Where calcium arsenate was added, somewhat less flea beetle damage was noted, but there was a light amount of spray injury. The plots receiving DDT were of superior appearance, upright, vigorous, and remarkably free from any trace of insects.

The contrast between the DDT plots and the other plots grew more noticeable as the season advanced. Examination of growing tips from the different plots indicated the protection furnished by DDT. Samples from the Bordeaux plots showed 4560 perforations per 10 tips, while similar samples from the DDT (wettable powder) plot showed only 264 feeding punctures and from the DDT (emulsion) plot, 220; and superficial examination of the plants in the latter plots failed to indicate any damage.

Yields were high in both plots sprayed with DDT. The highest yield was slightly over 466 bushels per acre in the plot where the DDT emulsion was applied. The yield in the DDT (wettable powder) plot was 96 bushels per acre (or 30 percent) greater than in the adjoining Bordeaux plot; and where the DDT emulsion was applied, the increase in yield was 148 bushels per acre or 46.5 percent greater than where Bordeaux alone was used.

Control of Onion Thrips. (A. I. Bourne.) Onion sets were preferred to seed onions because the cold, wet spring season prevented early preparation of the plot and sets would furnish material for tests much earlier than would seed onions.

Thrips infestation developed slowly after a somewhat late appearance. A very few were found by the third week of June, and hot dry weather in July promoted rapid increase. Throughout the Valley, the prevailing weather conditions delayed thrips development so that many of the fields of set onions were pulled before thrips had reached very great numbers. Some of the plantings of seed onions, maturing later in the summer following the hot dry weather of July and August, showed moderately heavy attack.

The first application of insecticides was on July 15 when the plants averaged 15 to 16 inches in height and had an average of about 30 thrips per plant, a comparatively light infestation.

Following very thorough application to relatively small plants, all the sprays gave excellent initial kill: Black Leaf 40, Ryanex, and DDT, 99 percent control; Derris and DDD, 95 percent or over. After 7 days, the Derris, DDT, and DDD plots showed no increase in thrips population; Black Leaf 40 and Ryanex, however, did not give prolonged protection.

Of the dusts, DDT and BHC (benzene hexachloride) gave practically complete control following heavy application, and only slight increase in thrips population after a 7-day interval. Plants dusted with BHC retained a pronounced odor for weeks, but the onions when harvested did not have their flavor impaired. Ryanex dust gave approximately 94 percent control.

Control of Cabbage Maggot. (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) The natural infestation of the cabbage maggot in the experimental planting at Waltham caused 79 percent commercial injury in 1947. In the same planting, one and two applications at 10-day intervals of benzene hexachloride–talc dust at the rate of 25-30 pounds per acre gave perfect control. The most effective dusts contained 5 and 3 percent benzene hexachloride, but dust containing 1 percent benzene hexachloride was commercially satisfactory.

Benzene hexachloride harrowed into the soil at the rate of 2 pounds per acre before transplanting failed to give satisfactory protection.,

The treatments which gave excellent control produced 85 to 95 percent marketable heads, and there was no taste or odor contamination at harvest. Although no records were obtained, observations indicated that the cutworm injury was completely eliminated by these treatments.

Studies of Odor and Taste Contamination from Soil Treatment with Benzene Hexachloride. (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.)

Benzene hexachloride is an effective insecticide for the control of wireworms and cabbage maggot. However, it has a strong, persistent musty odor and taste which may be imparted to vegetables grown in treated soil.

In the experimental garden where areas were treated with benzene hexachloride at the rate of 2, 3, and 5 pounds per acre, carrots, onions, parsnips, and radishes were judged free from odor or taste contamination at the harvest by fifteen disinterested testers. Potatoes were contaminated at all dosages, and beets at the higher rates of application.

In general, the odor and taste of BHC were accentuated by boiling and baking. Potatoes still retained the odor to an undesirable degree seven months after harvest. Radishes and turnips were contaminated when the benzene hexachloride was applied as a dust to the plants after the shoulder was developed above ground.

Control of Squash Vine Borer. (W. D. Whitcomb, W. J. Garland, Waltham.) The natural infestation by the squash vine borer in the experimental plantings at Waltham in 1947 was 49.5 borers per vine. Applications of dust gave appreciable protection when applied at weekly intervals during July.

The most effective treatment was dusting with 3 percent DDD (Rhothane) which gave 81.6 percent protection. Other dusts which gave satisfactory protection were effective in the following order: 5 percent methoxy DDT; 0.5 percent DDT plus 0.06 percent pyrethrins; and 40 percent ryania powder.

The infestation in both the untreated and the dusted plants was about 30 percent greater in *Cucurbita maxima* plants than in *C. pepo*.

Biology and Control of Common Red Spider on Greenhouse Plants. (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) Parathion, a new organic phosphate insecticide, was found to be very effective for control of the

greenhouse red spider on greenhouse roses when used as a 25 percent wettable powder. Infestation before spraying averaged 35.6 spiders per leaf on Better Times variety, and 14.8 spiders per leaf on Briarcliff. When Parathion was applied as a spray at the rate of ¼, ½, and 1 pound (equivalent to 1, 2, and 4 ounces of toxicant) per 100 gallons of water, all spiders were killed at each dilution. Furthermore, all spiders were killed on specimen plants protected by a hood of sheeting cloth, indicating very effective toxic action from the fumes. Mask and gloves were used during application.

No spiders have been found on these plants for three months after spraying, and no significant injury to the rose plants occurred.

Apple Maggot Emergence. (W. D. Whitcomb, Waltham.) Emergence of apple maggot flies at Waltham was the latest for any season since the cages have been operated, and applications of spray and dust for control of this pest, consequently, were delayed. The first fly was not found until July 6 which is 10 days after the average (8-year) date. Fifty percent emergence was reached on July 20, and flies continued to appear until August 18, which is about two weeks later than usual.

Control of Plum Curculio in Apples. (W. D. Whitcomb, Waltham.) In the vicinity of Waltham, the plum curculio continued to be the most destructive insect pest of apples. On four unsprayed trees, 594 curculio beetles were collected by jarring between May 28 and June 18, 1947. Peak collections on June 2 and 16 indicated the periods of maximum activity when spraying was necessary for effective control.

In laboratory examinations the number of eggs in gravid female beetles was found to average 29.6, with a maximum of 43.

Insectary experiments using five pairs of beetles per cage, with apples as food, showed 41 punctures per beetle on the unsprayed apples in the 30 days of the experiment. DDT–lead arsenate killed all of the beetles in 6 days, with 2 punctures per beetle. BHC (benzene hexachloride), 3 pounds of 6 percent gamma isomer in 100 gallons of water, was about half as effective, and at 2 pounds per 100 gallons was unsatisfactory. The addition of HETP (hexaethyl tetraphosphate) 1-1600 prevented oviposition completely and gave excellent protection for about 7 days.

In orchard experiments involving the examination of about 18,000 apples, the combination of lead arsenate 2 pounds and 50 percent DDT wettable powder 2 pounds in 100 gallons gave the best control and was more effective by about 8 percent than lead arsenate alone at either 4 or 6 pounds in 100 gallons. BHC, 6 percent gamma isomer, at the rate of 3 pounds in 100 gallons permitted 42 percent of the fruit to be stung and was unsatisfactory. The addition of HETP 1-1600 to lead arsenate was less effective in the orchard than in the laboratory because its rapid breakdown failed to maintain protection between applications.

Study of Naphthalene and Similar Compounds as Greenhouse Fumigants. (W. D. Whitcomb and W. J. Garland, Waltham.) Experimental fumigations with aerosols containing a naphthalene base fumigant (Fulex) failed to satisfactorily control the common red spider on carnations in one 4 or 6 hour exposure (47-58 percent dead), but were effective in two successive exposures at 7-10 day intervals (86-100 percent dead). The aerosol was effective when discharged into the upper part of the room, but not from the floor.

Effective formulae were 25 percent Fulex concentrate with Freon and 20 percent Fulex-azobenzene with Freon. Addition of approximately 5 percent gamma isomer of benzene hexachloride to both Fulex concentrate and Fulex

azobenzene aerosols gave 100 percent control of aphis on carnations and maintained the same effectiveness against the red spider mite.

Experimental fumigations in a commercial greenhouse with four applications of 17.5 percent azobenzene powder in a pressure fumigating can failed to give satisfactory control of the citrus mealybug on gardenia, although aphis and red spider mite were completely killed. The standard dosage of 2 pounds per 20,000 cubic feet was increased to 7½ pounds without controlling the mealybug. No injury to gardenia plants occurred, but the blooms and the paint on the greenhouse were noticeably stained.

Biology and Control of the Celery Plant Bug. (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) Although the first generation of the celery plant bug (*Lygus campestris* L.) in July, 1947, was very small, the second generation in August and September was moderately abundant and control measures were necessary on many celery plantings in eastern Massachusetts.

Life history studies showed the time for development from egg to adult was 18.3 days in August, and 32 days in September, the difference being due almost entirely to the slow growth of the fourth nymphal instar during the cool weather in late September.

Sprays and dusts to control injury by bugs of the second generation were applied August 15 and September 3. DDT wettable powder in sprays containing 0.12, 0.06, and 0.03 percent DDT gave excellent control with no significant differences between the dosages, although reinfestation was prevented in direct proportion to the dosage. A dust containing 0.5 percent DDT and 0.06 percent pyrethrum was as effective as the sprays containing DDT. Dusts containing 40 percent ryania and 5 percent methoxy analog of DDT were unsatisfactory.

The size and weight of the average celery plant were significantly correlated with the injury by the celery plant bug in most control treatments, as shown in the tabulation.

Treatment	Injured Stalks at Harvest	Average Weight of Stalks
Spray	(percent)	(ounces)
DDT 50, 2 pounds per 100 gallons	None	46.4
DDT 50, 1 pound per 100 gallons	2.63	47.0
DDT 50, ½ pound per 100 gallons	3.50	50.2
Dust		
DDT 0.5 percent–pyrethrins 0.06 percent	5.26	50.6
DDT 3 percent	8.77	45.2
Ryania 40 percent	45.61	42.8
Methoxy 5 percent	64.91	47.0
Check	74.34	38.2

Preliminary analyses by A. F. Spelman of the Control Service showed DDT residue well within the tolerance of 7 p.p.m. three weeks after treatment in July. In August the residue on the stalks was satisfactory, although with the stronger sprays the residue was excessive on the leaves but not on the stalks. Further analyses are needed and are planned.

Biology and Control of the Grape Cane Girdler. (W. D. Whitcomb, Waltham.) Grape cane girdler beetles lived an average of 61 days when confined in cages with a supply of fresh grape canes daily, and made an average of 234 feeding

scars per beetle. The greatest activity occurred between June 20 and July 15, but feeding was continued to September 19, which was 99 days after the observations were started.

DDT 50 percent wettable powder sprayed on canes in the insectary cages killed 4 pairs of beetles in 3.12 days and permitted 0.87 feeding scars per beetle during their life. Of ten different combinations and dosages of DDT, lead arsenate, and benzene hexachloride, five killed the beetles more quickly and seven prevented as many feeding scars. Benzene hexachloride reduced feeding scars by 57 to 86 percent and was significantly more effective in this respect than DDT or lead arsenate.

Study of Euonymus Scale and Its Control. (W. D. Whitcomb and C. N. Warner, Waltham, in cooperation with the Bartlett Tree Expert Company.) Studies on the Euonymus scale were started early in 1948 with dormant spraying treatments. When an 83 percent white oil emulsion was used in sprays containing 2, 3, and 4 percent actual oil, only the 4 percent dilution was satisfactory.

Reinfestation by crawlers following dormant sprays was reduced 100 percent by Elgetol 1½ percent; 98.7 percent by Elgetol 1 percent; and 86.9 percent by 4 percent oil emulsion.

In 1948 the first crawlers hatched June 14 and maximum activity was reached June 28-July 2 which is considerably later than has been estimated previously. Microscopic examination of female scales showed a maximum of 81 and an average of 61.5 eggs per scale.

An examination of 35 species and varieties of Euonymus growing at the Arnold Arboretum showed 8 species and 8 varieties heavily infested and 5 species and 4 varieties uninfested. No infestation was found on *E. alata* and its varieties, while *E. europea* and its varieties were all heavily infested.

Sprays to Prevent Scolytid Infestation of Elm Logs. (W. B. Becker.) At Springfield a number of sprays were applied once in the early spring when the weather was still cool (March 13, 1947) to the entire bark surface of winter-cut logs of American elm before Scolytids could attack them. Each test involved 20 to 22 square feet of bark with a maximum thickness between 3/8 and 3/4 of an inch and the quantity of spray applied was what the operator estimated to be necessary to thoroughly wet the surface of the bark (66 to 155 ml. per square foot). *Scolytus multistriatus* Marsham is abundant in the vicinity, but only *Hylurgopinus rufipes* (Eich.) infested the unsprayed control logs exposed at this season.

One percent DDT sprays (a wettable powder, an emulsion, and solution in No. 2 fuel oil), orthodichlorobenzene in No. 2 fuel oil (1 to 8 by volume), pentachlorophenol in No. 2 fuel oil (1 to 10 by volume), and monochloronaphthalene in No. 2 fuel oil (1 to 12 by volume) all gave 100 percent prevention, based on the number of exit holes found per square foot of bark in the late fall, as compared with the number in unsprayed check logs. The spraying of frozen or ice-coated logs, of course, may not result in such good control.

Other logs cut at the same time were sprayed as above but during warm weather (June 13, 1947). Each test involved 20 to 24 square feet of bark with a maximum thickness of 3/8 to 3/4 of an inch. Between 104 and 133 ml. of spray were applied per square foot of bark. Apparently the logs had only recently been attacked when the spray was applied, because boring dust was on the logs then; but examination in the fall revealed that eggs had hatched in few to none of the egg galleries in the sprayed logs. While no *S. multistriatus* were found in any of the sprayed logs, the ratio of *S. multistriatus* to *H. rufipes* brood galleries in the unsprayed control logs was 1 to 8.

In comparison with the control logs, 100 percent prevention or control was obtained with No. 2 fuel oil alone, pentachlorophenol in No. 2 fuel oil (1-10 by volume), and monochloronaphthalene in No. 2 fuel oil (1-12 by volume). The one percent DDT wettable powder spray and the orthodichlorobenzene in No. 2 fuel oil (1-8 by volume) gave 91.6 and 84.2 percent prevention, respectively, based on the number of exit holes per square foot of bark; but on the basis of the number of exit holes per egg gallery (with and without hatched eggs) 76.6 and 79.9 percent control, respectively, was obtained.

Spraying to Prevent Twig Feeding by the Smaller European Elm Bark Beetle. (W. B. Becker.) Several new insecticides were tried in four types of spraying applications to prevent twig feeding on American elms by the smaller European elm bark beetle, *Scolytus multistriatus* Marsham, using the method described on pages 41-42 of last year's annual report (Bulletin 441).

1. *With Small Compressed-air Garden Sprayers.* The sprays were applied thoroughly at close range to low-growing branches of elms. Dormant and foliage applications of commercial DDT emulsion and wettable powder sprays at the low strengths found successful against many defoliating insects did not give good protection against *S. multistriatus* twig feeding after many days of weathering. No spray injury resulted to the elms at these low concentrations.

Dormant applications: Higher concentrations of several commercial DDT emulsions gave increasingly longer protection on the sprayed portions of twigs. Good protection for 100 days was sometimes obtained with 1 percent DDT emulsions, but much less often with 0.5 percent; while 2 percent DDT emulsions were effective for 200 days. The addition of lead arsenate to DDT emulsions (38 grams per gallon of 0.5 percent DDT spray) made no great difference in the results obtained at that strength. A 4 percent chlordane emulsion did not remain effective so long as a 1 percent DDT emulsion. No spray injury to the elms resulted from any of these dormant applications.

Foliage applications: In mid-August, 2, 1, and sometimes 0.5 percent commercial DDT emulsion and wettable powder sprays applied to previously unsprayed elms gave complete protection on sprayed parts of twigs for 109 to 113 days, after which these tests were suspended. No spray injury to the elms resulted from the wettable powder sprays, but slight foliage injury resulted from some 1 percent commercial DDT emulsions and moderately severe injury from some 2 percent DDT emulsions. Sugar maples and some other plants growing next to sprayed elms were injured more than the elms by these sprays. Spider mite damage sometimes followed DDT applications to elm foliage. A 2 percent chlordane emulsion gave much shorter protection and caused no injury. Wettable powder sprays of benzene hexachloride (151.4 grams of a 50 percent wettable powder per gallon), Ryania SC50 (76 grams per gallon), and Ryanex (151.4 grams per gallon) gave still less protection but caused no injury.

2. *With High-powered Hydraulic Sprayers* (35 gallons a minute capacity): Only DDT emulsions, commercial and laboratory-prepared, were used in this equipment. On low branches protection was somewhat comparable to that reported for DDT emulsions in the previous section. The principal difficulty lay in obtaining equally long-lasting protection in the upper parts of the elms, even though the spray always reached over the tops of the trees, which were up to approximately 60 feet high. As much as 25 gallons of spray was used on individual elms of medium size for thorough coverage.

Dormant applications: DDT emulsions, 1 and 2 percent, gave good, sometimes complete, protection at the top of an elm 41 days later. After 64 days, protection at the top was poor to fair from the 1 percent emulsion and poor to good from the 2 percent emulsion. After 112 days, protection was practically all poor at the top. No spray injury to the elms resulted.

Foliage applications: In mid-August these same elms were sprayed again and others sprayed for the first time. Special attention was given to spraying the tops. With 1 percent DDT emulsions, protection at the tops was poor to good 67-70 days later, but mostly poor after 117 days. With 2 percent DDT emulsions, protection at the tops was good after 67-69 days and fair to good after 117 days. Little to no injury to the elms resulted from these applications.

3. *With Mist Blowers:* The mist blower described in last year's annual report (Bulletin 441, p. 42) was used again. When the low dosages reported as successful against gypsy moths and other defoliating insects on shade trees (up to 1 quart of a 12 percent DDT solution or emulsion per medium to large elm) were applied in these experiments or with a similar mist blower on a regular municipal tree spraying operation, good protection against twig feeding by *S. multistriatus* was not obtained at any height, even after only a few days of weathering.

Dormant applications: When one gallon of a 12 percent DDT solution (diluted with kerosene) was sprayed at a medium to large elm, protection at the top was poor 43 days later. Two gallons gave somewhat better results then, but very poor results after 73 days. Three gallons gave good results at the top after 71 days but poor results after 148 days. None of these applications caused noticeable injury to dormant elms, but a sugar maple growing close to the elm which received three gallons was severely injured by the spray.

Foliage applications: One gallon of a 12 percent DDT emulsion, applied per tree in mid-August, gave poor results 43 days later at the top of a tree which had not been previously sprayed. Protection at the tops was fairly good from two and three gallons per tree after 44 days, but was poor after 77 days from two gallons and only slightly better from three gallons. Better protection was always obtained in the lower parts of the trees and was in proportion to the amount sprayed at the tree. These mid-August foliage applications caused little noticeable injury to the elms, except on the lower branches of the tree which received three gallons of the emulsion and where the blower passed too close to the other trees.

4. *With an Airplane.* Through the courtesy of the Field Headquarters, Gypsy and Browntail Moth Control, of the U. S. Bureau of Entomology and Plant Quarantine, and the Entomology Department of the Connecticut Agricultural Experiment Station, the effectiveness of airplane applications of DDT against twig feeding of *S. multistriatus* was studied. Deciduous forest areas in Connecticut were sprayed by airplane early in the spring with DDT at dosages used experimentally to combat gypsy moth caterpillars. Flying and spraying conditions were reported excellent, no foliage was yet present, and all glass plates at the site of these experiments, both on the ground and on branches, were well covered with the spray. Prevention of *S. multistriatus* feeding was unsatisfactory throughout the tests, which lasted 48 days. Even after only three days of weathering on a plot sprayed with as much as 2 pounds of DDT (technical grade) dissolved in 2 gallons of liquid (xylene and kerosene) per acre, only 45.4 percent prevention was obtained. All elm twigs used in this test were from branches 20 to 30 feet high in the tree.

DDT Residues on Grass Beneath Elms Sprayed for Elm Bark Beetles. (W. B. Becker and A. F. Spelman.*) The Feed and Fertilizer Regulatory Service cooperated by making DDT analyses of grass collected from pasture areas on which the spray dripped and drifted from elms sprayed with DDT emulsion from high-powered hydraulic sprayers. DDT (technical grade) was used at the rates of 16 and 8 pounds per 100 gallons, and as much as 25 gallons of spray was applied per tree. The residue was determined by the total chlorine method and *based on the oven-dry weight of the grass.*

August 15 application (soon after removal of cut hay); After 4 days with 0.52 inches of rainfall, the residue from the 16-pound application was 6,885 p.p.m. DDT; from the 8-pound application, 4,035 p.p.m. After 68 days with 4.55 inches rainfall, the corresponding residues were 1,658 and 851 p.p.m.

April 25 application: After 96 days with 11.63 inches rainfall, the residue from the 16-pound application was 43 p.p.m. DDT; from the 8-pound application, 45 to 50 p.p.m.

Such high DDT residues would seem to be undesirable and possibly hazardous where food for man or animals is involved. More detailed studies are in progress.

FEED AND FERTILIZER CONTROL SERVICES

John W. Kuzmeski in Charge

The feed, fertilizer and milk testing laws are administered as one service and the operation of each, with the exception of the milk testing law, is reported in annual bulletins.

Under the milk testing law 4,915 pieces of Babcock glassware were calibrated and 177 certificates of proficiency in testing were issued. All milk depots and milk inspection laboratories in the Commonwealth were visited at least once to check apparatus and general conduct of the work.

In addition to the regulatory work the Feed and Fertilizer Control laboratories have examined feeds, fertilizers, and other agricultural materials for citizens of the Commonwealth without charge whenever the results were considered of interest to the general public or to the Control Services.

Considerable work has been done on research projects in cooperation with other departments of the University and Experiment Station. The results of such work are reported by the departments originating the projects.

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Breeding Snapdragons for Variety Improvement and Disease Resistance. (Harold E. White, Waltham.) A dark pink flowered strain of Helen Tobin has been developed into a pure inbred line and seed has been distributed to local growers. The original Helen Tobin, which is a light pink variety, has been reported by several florists to be a good spring blooming variety to follow chrysanthemums. This variety, since its first introduction, has been used very successfully for an outdoor crop by a florist near Tampa, Florida; this year the firm plans to grow a crop of 8,000 to 10,000 plants. George J. Ball, Inc., West Chicago, Illinois, and other commercial growers are using Helen Tobin as breeding stock because it is an excellent seed producer and has other desirable characters.

* Senior chemist, Feed and Fertilizer Regulatory Service.

Excellent hybrids of the Tobin variety have been produced by inter-crossing with other commercial varieties. Local florists have been using these hybrids for two years with fine results. A sufficient quantity of stock seed of Tobin hybrids is being produced at Waltham to supply these growers.

The Waltham Field Station rust-resistant, pink-flowered strain of snapdragon for garden culture is being tested by approximately fifty home gardeners in the State. These tests are being conducted in cooperation with the Garden Club Federation of Massachusetts. The variety will be named and provisions made for introduction through local seedsmen if performance in these tests is satisfactory.

Sodium Selenate as a Red Spider Control. (Harold E. White, Waltham.) Carnation plants growing in benches were treated with selenium-bearing phosphate known in the trade as P-40. Applications were at the rate of 3, 4½, and 6 pounds per 100 square feet of bench area. Two applications of this material were made during the growing season, one in August and a second in November.

All the treatments at the higher dosages, 4½ and 6 pounds per 100 square feet, gave effective control of red spider from November through June, a period of 8 months. Red spider became abundant in May and June on untreated carnation plants and on those receiving the dosage of 3 pounds of P-40 per 100 square feet.

Ageratum, Lantana, Coleus, and Stevia were grown in 5-inch pots and treated with P-40 at the rate of ¼, ½, and 1 teaspoonful per pot. The ¼ teaspoonful dosage did not give effective control over a period of 6 to 8 weeks and the ½ teaspoonful treatment gave only partial control. The dosage of 1 teaspoonful P-40 per pot gave complete control.

Neither carnation plants nor potted plants showed harmful effects from treatments with P-40, even at the high dosage rate.

Samples of soil and plant material were taken monthly from the P-40 treated carnation plants for selenium analysis. The analytical work on these samples has not been completed sufficiently for a report at this time.

It is of interest to note that composted soil used at the Waltham Field Station shows an analysis about 1 to 1½ p.p.m. of selenium. Tests of black swamp peat from the Station farm show that 1 to 2 p.p.m. of selenium occurs in this soil. Soil samples from market garden land near Waltham were taken for further analysis as to presence of selenium.

This project is being conducted in cooperation with the Department of Agronomy and the Waltham Field Station entomologists.

Breeding for Varietal Improvement of Geraniums. (Harold E. White, Waltham.) Two seedling geraniums, derived from inbreeding and hybridizing of commercial varieties, have been named and are being introduced in 1948-49.

The seedling named Dorothy is a cross between Salmon Ideal and Beaute Poitevine. It is a vigorous grower, is salmon pink in color, has large flower trusses, and blooms freely in winter or summer. The flower color does not fade under high temperature conditions of summer.

The second seedling has been named Annette and was obtained by selfing the variety Salmon Ideal. This variety has bright red flowers, is a vigorous plant, blooms very freely, and retains its flower color under high temperature conditions.

These new varieties have been compared with commercial varieties at Waltham for three years. Stock has been released to the firm of H. J. Borowski & Sons, Inc., Norwood, Massachusetts, for propagation and will be introduced to the trade in the fall of 1948.

Sufficient stock of the varieties has been retained by the Waltham Field Station to perpetuate the strains.

Insulation of Flower Shipping Boxes. (Harold E. White, Waltham.) In October, 1947, a new plastic material was obtained from the Dow Chemical Company, Midland, Michigan, to determine its adaptability as an insulant for flower shipping containers. This material was supplied in especially cut boards 1 inch and ½ inch thick for liners to be fitted inside shipping boxes. The product, known as Styrofoam, a plastic, multicellular foam produced by expanding polystyrine 40 times, is snow white in color.

Styrofoam (Type 103.7) has a thermal conductivity K factor of 27-30, is resistant to moisture, absorbing 6 percent or less by volume. Also it is resistant to fire, burning at the rate of 7 to 8 inches per minute, has great structural strength, and is very buoyant. A cubic foot weighs a maximum of 2 pounds. At present Styrofoam is produced commercially for use in refrigeration plants, lockers, storage warehouses, and railroad cars.

Cardboard shipping boxes 36 x 15 x 9 inches and 48 x 18 x 10 inches were lined with Styrofoam boards. Other boxes were lined with 10 sheets of newspaper covering the sides, ends, bottoms, and tops. Styrofoam-lined and newspaper-lined boxes were wrapped with one sheet of manila paper. Two hundred carnation flowers were packed in each box. All boxes were placed outdoors with a maximum exposure period of 18 hours. Hourly temperature readings within the boxes and on the outside were obtained by recording clock thermometers. The lowest outside temperature recorded during the test was between 11° and 12°F.

Experiments on the effect of low temperatures on cut flowers, conducted by the U. S. Department of Agriculture, show that most flowers, including carnations, are injured at a critical temperature of 28°F. or below. The shipping boxes lined with ½ inch Styrofoam boards dropped from an initial temperature of 62°F. to 28°F. in a period of 6 hours, whereas the temperature in the newspaper-lined box fell to 26°F. in 5 hours. The outside air temperature dropped to 12°F. The lowest temperature in the Styrofoam lined box was 26°F., and in the newspaper lined box 24°F.

Interior temperature of boxes lined with 1-inch Styrofoam dropped to 28°F. in 8 hours, whereas the temperature in the newspaper-lined box fell to 28°F. in 4 hours. In these tests temperatures within boxes lined with newspapers dropped more rapidly than in boxes prepared with Styrofoam.

Styrofoam, as an insulant for flower-shipping containers, offers several desirable features, such as lightness in weight and a low moisture factor; it is a sterile medium and has a low thermal conductivity factor. It offers possibilities as an insulation material against low temperatures and as a material to protect flowers from extreme heat during shipment. Its use presents some problems such as production for this specialized field of use, the most satisfactory method of applying the lining to the boxes, and the cost of such an insulant as compared with newspaper.

Polyvinyl Resin Geon 31X Latex as a Flower Preservative. (Harold E. White, Waltham.) Geon 31X Latex is a water-dispersible resin which, when applied to plant material or other objects, forms a thin transparent film. Materials can be treated by dipping them in a solution of the Latex resin or they can be sprayed.

Gardenias, carnations, camellias, cymbidium orchids, geraniums, and passion-flowers were treated with 10, 20 and 30 percent solutions of the Latex. Pigmented flowers, such as red, pink, or yellow, were affected unfavorably by even the 10

percent solution and did not keep as well as untreated blooms. White flowers, such as gardenias and carnations, treated with the 10 and 20 percent solutions, showed great variability in keeping quality as compared with untreated blooms.

Treatment of gardenia flowers did not give consistent results in keeping the petals from turning brown, even for a period of 24 hours. Individual flowers within the treated lot turned brown while others remained in good condition. This reaction took place on blooms when kept under refrigeration and at room temperature. The variable response of gardenia flowers to the treatment seems to be due to physiological differences in the flowers.

Florists' ferns treated with the resin solutions kept in much better condition than untreated ferns. The treated ferns kept for a week at room temperature before the leaflets began to shed, while the check bunches were in poor condition after 24 hours. *Asparagus plumosus* treated with 10 and 20 percent solutions gave excellent results.

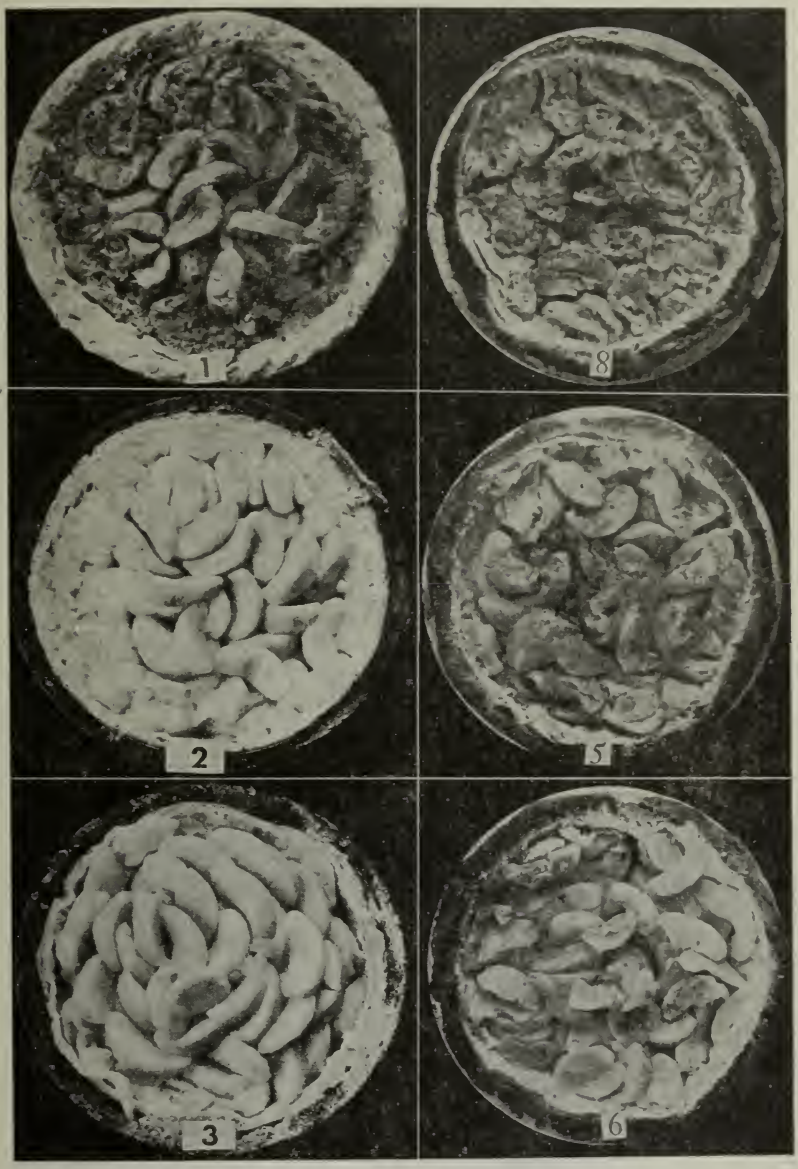
Passionflowers close shortly after they are cut and usually are treated with paraffin to keep them open. Treatment of blooms with Geon 31X Latex in 50 percent concentration was not effective in keeping such flowers open.

DEPARTMENT OF FOOD TECHNOLOGY

C. R. Fellers in Charge

Frozen Apples. (W. B. Esselen, Jr., C. R. Fellers, and J.E.W. McConnell.) On the basis of experiments conducted here during the past three years as well as commercial experience and practice it would appear that there are several procedures which can be employed to produce frozen apples of satisfactory quality. Of the different methods used to prevent darkening, such as blanching, deaeration, sulfurous acid dips, ascorbic acid, syrups, and others, each has certain advantages and disadvantages. The selection of which anti-darkening to use may depend upon the volume of production, plant facilities, and demands of the consumer. For example, apples treated with sulfurous acid may have a residual sulfur dioxide flavor unless care and control are exercised during the operation. Blanching causes some loss of flavor and solids but does not impart off-flavors. The use of ascorbic acid can yield good results if specific procedures are followed which are applicable to the particular raw material and plant operation. The use of sugar or syrup in conjunction with ascorbic acid or other treatments may present a problem because the apples when thawed will have an excessive quantity of syrup and juice. Some consumers may object to this excess syrup as being a waste of sugar and apple flavor. On the other hand the syrup is a valuable adjunct to the frozen apples in providing protection against oxidation during freezing and thawing. It can be used effectively if it is drained from the thawed slices, concentrated, and added to the pie. Some bakers handle the sugar in this manner.

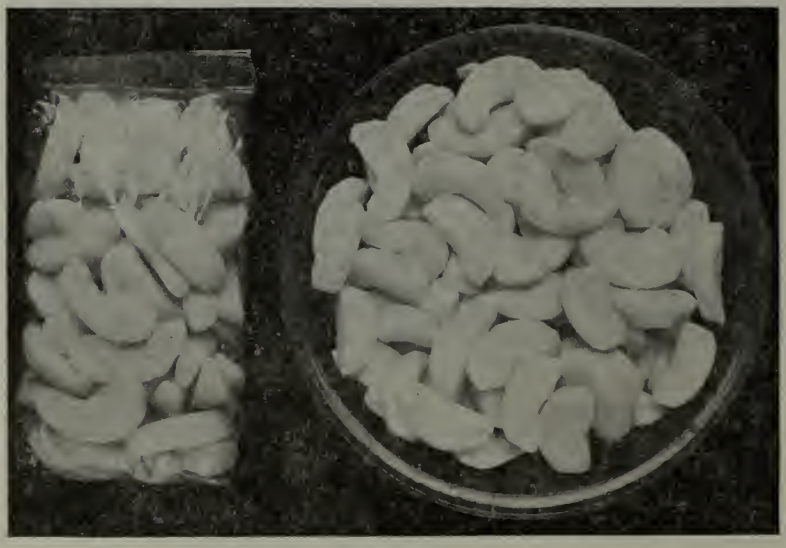
It has been frequently observed that pies made from properly prepared frozen apples were superior in fresh apple flavor and aroma to pies made from untreated fresh apples. The effectiveness of anti-darkening and antioxidant treatments given frozen apples carries through into the finished pie and tends to stabilize the apple flavor. The use of suitable antioxidants in pies made from fresh apples is worthy of consideration from the standpoint of maintaining optimum flavor.



1. Pie Made from Untreated Frozen McIntosh Apples. **2.** Pie Made from Frozen McIntosh Apples Treated with Sulfur Dioxide. **3.** Pie Made from Frozen McIntosh Apples Treated with Sulfur Dioxide and Calcium Chloride. **8.** Pie Made from Freshly Prepared Untreated McIntosh Apples. **5.** Pie Made from Prepared McIntosh Pie Apples Treated with Sulfur Dioxide and Calcium Chloride and Stored for Two Weeks at Room Temperature. **6.** Pie Made from Prepared McIntosh Pie Apples Treated with Sulfur Dioxide and Calcium Chloride and Stored for Three Weeks at 35° F.

Canned and Frozen Baked McIntosh Apples. (W. B. Esselen, Jr., C. L. Rasmussen, and C. R. Fellers.) Canned and frozen baked McIntosh apples prepared without added calcium chloride were quite soft and mushy and did not retain their shape. They retained a satisfactory degree of firmness when treated with 0.05 to 0.10 percent calcium chloride. In no instance did the calcium chloride cause an off-flavor in the product. The characteristic McIntosh flavor was well retained in both the canned and frozen apples. From the standpoint of appearance glazed apples were rated best, with vacuum-treated and core-filled apples in a descending order of preference. Scoring completely cored apples about the periphery, before baking or glazing, reduced the tendency of the skin to split. Baldwin and Northern Spy apples retained their shape and texture very well without added calcium. In fact, those treated with calcium were considered to be too firm and rubbery.

Prepared Fresh McIntosh Apple Slices. (W. B. Esselen, Jr., C. L. Rasmussen, and N. Glazier.) In the preparation of fresh sliced apples for the bakery or consumer trade there are several factors that must be overcome or controlled in the production and distribution of a good quality product. The objectionable browning or discoloration of the slices may be satisfactorily controlled by treatment with sulfur dioxide or for short periods of time by means of a treatment with an acid and salt solution. While the concentration of sulfur dioxide required to maintain color may vary somewhat depending upon the condition of the apples, etc., a 10-minute dip in a solution containing 1500 p.p.m. has been found to be satisfactory under our conditions. Apples treated in this manner maintained a good quality for from one to two weeks when stored at room temperature and for three weeks or longer when held at 35°F. During storage for a week or longer a considerable amount of liquid tended to leach out of the slices and accumulate in the bottom of the container.



Consumer Package (22 ounces) of Prepared Fresh McIntosh Pie Apples.

A 10 or 15 minute treatment in a solution containing 5 percent salt, 0.5 percent ascorbic acid and 0.4 percent citric or ortho-phosphoric acid gave good results if the sliced apples were to be held for only a short time. Refrigeration is essential for apple slices treated in this manner.

For soft-textured apples such as the McIntosh the addition of 0.10 percent calcium chloride in the dipping solution is effective in maintaining the texture of the slices when they are baked in pies.

Apple-Cranberry Juice. (W. B. Esselen, Jr., K. M. Hayes, and C. R. Fellers.) An attractive and palatable fruit juice can be made by blending from 12 to 15 percent cranberry juice with apple juice. It is necessary to give the apple juice a preliminary flash pasteurization treatment in order to inactivate enzymes which would otherwise destroy the red color of the cranberry juice when the two are mixed together prior to final processing. The enzyme present in the apple juice, which destroyed the red color of the cranberry, was inactivated by heating at 190°F. for 0.5 minute or at 180°F. for 2.0 minutes.

Pre-Packaged Fresh Cranberries. (C. R. Fellers, K. M. Hayes and W. B. Esselen, Jr.) A new development in the merchandising of fresh cranberries has been the packaging of the fruit in transparent bags or packages for the retail trade. During the past year a study has been made of the effect of packaging in small sealed containers on the keeping qualities of cranberries and of the various kinds of packaging material used for the storage and marketing of the fruit.

Of the packaging materials studied, single thickness 450 LSAT cellophane was found to possess the best qualities for pre-packaging fresh cranberries. This type of package had good transparency and permitted the fruit to respire slowly with a minimum loss in weight due to desiccation and respiration. Cranberries in packages stored at room temperature (65°-75°F.) could be held for five to six days without appreciable breakdown, while at 35°F. the packaged fruit remained in good condition for from four to five months. This type of package is being adopted by several cranberry marketing agencies.

Factors Affecting the Viability of Dried Bakers' Yeast. (R. E. Morse and C. R. Fellers.) Methods for the laboratory preparation of dried bakers' yeast were investigated. Yeast was prepared which was similar in chemical composition and leavening properties to good grade commercial dried yeast.

A new method for testing the viability of dried bakers' yeast with triphenyl tetrazolium was developed. A carmine color, developed by reduction of the dye by yeast, is extracted with acetone and measured with a spectrophotometer. Good correlation between yeast viability and color development was obtained.

Exposure to light and type of package showed little or no effect on the viability of stored dried yeast. A low storage temperature and humidity had a pronounced favorable effect on the retention of viability in dried yeast. Nutritional and environmental factors were of paramount importance in causing yeast cells to develop dormancy and longevity in the semi-desiccated state.

The Composition and Nature of Apple Protein. (S. G. Davis and C. R. Fellers.) Apple tissue was found to contain approximately 0.2 percent protein. Isolated apple protein material had a nitrogen content of 8.5 percent. Amino nitrogen amounted to 93.5 percent of the total nitrogen, and the 16 amino acids (leucine, isoleucine, valine, phenylalanine, tryptophane, glutamic acid, alanine, histidine, arginine, threonine, methionine, lysine, aspartic acid, serine, proline and cystine) for which values could be obtained accounted for 83.6 percent of this amount.

Notable amounts of aspartic acid and glutamic acid appeared to exist free or in the form of simple peptides or amides in the apple tissue. Tryptophane could not be detected in either the protein preparations or the apple tissue itself.

Jar Rings for Home Canning. (W. B. Esselen, Jr.) An investigation on the tendency of home-canning jar rings to impart off-flavors to canned foods has been completed. All natural rubber or a combination of natural and synthetic rubber (GR-S) can be used to make jar rings which will not impart undesirable flavors to foods. In using synthetic rubber it is important that the raw material be selected for this particular use. In some cases chemicals added in the fabrication of jar rings such as accelerators or antioxidants can also contribute off-flavors, particularly off-flavors characterized by a bitter taste. Apple sauce was found to be a particularly good canned food for testing jar rings. If the rings which are used to seal the jars have a tendency to cause off-flavors it will sometimes show up after three months storage at room temperature but a six months storage period prior to testing is to be preferred.

Home Freezing. (W. B. Esselen Jr., J. E. W. McConnell, and N. Glazier.) Work is being continued on the quality of different varieties of fruits grown in this area when frozen. The fruit varieties have been provided through the cooperation of the Department of Pomology. The products frozen during the 1947 season included 18 varieties of strawberries, 10 of blueberries, 11 of cherries, 18 of raspberries, 17 of plums, 16 of pears, 27 of peaches, and 8 of currants. A number of the varieties of frozen plums were quite attractive and flavorful but there was a tendency for many of them to have a tough skin. Frozen red currants made a very satisfactory dessert fruit. In general the frozen pears lacked flavor and were not considered satisfactory. Some variation in quality from season to season has been observed in the different varieties of frozen fruits.

Process Times for Glass-Packed Foods. (Cooperative project with the Glass Container Manufacturers Institute, The National Canners Association (Washington, D. C., and San Francisco, Calif., laboratories), and the California State Department of Health.) (J. E. W. McConnell and W. B. Esselen, Jr.) Experimental heat penetration data obtained with bentonite suspensions (1 and 5 percent) in glass jars of different sizes have been used in working out come-up time and cool correction factors which can be used in the application of Ball's mathematical methods for the calculation of process times for low-acid glass-packed foods. The percentage of the come-up time which may be applied as process time for glass containers corresponds very closely to the 42 percent value used for tin cans.

Under conditions of convection heating, jars appear to heat more slowly than cans of corresponding sizes. Heat penetration data indicated no difference in the heating rates of cans processed in steam and in water. In the case of conduction heating, the heating rate is somewhat faster for cans than for jars, in sizes larger than the "baby food" size. This results in a somewhat greater lethality for a given process for cans than for jars of corresponding sizes, with the exception of the "baby food" size.

It was found that rapid cooling of 5 percent bentonite in jars or cans can be brought about by high vacuum and adequate headspace. When the vacuum starts to form in the containers during the cool, boiling of the contents frequently occurs, and with this agitation of the contents, rapid cooling results.

Tin-Treated Glass Containers for Processed Foods. (W. B. Esselen, Jr., and Fagerson.) Glass containers whose inner surfaces had received a thin coating

of a tin compound were compared with similar untreated glass containers to determine the effects of the tin treatment on ascorbic acid, color, and flavor retentions of various foodstuffs packed in these containers. No significant differences were observed in apple juice, orange juice, asparagus, grapefruit juice, strawberries, green beans, and tomato juice, which were the foods selected for the study. The maximum amount of tin recovered from any of the foods packed in the treated containers was 5 p.p.m. from green beans which had been stored at 100°F. for six months.

Spectral studies on amber glass bottles indicated that the tin treatment did not appreciably affect the light transmission characteristics of these containers.

The Effect of Processing Conditions of Time and Temperature Upon The Enzyme Systems of Canned Acid Foods. (W. B. Esselen, Jr., A. M. Kaplan, and J. E. W. McConnell.) Processing times and temperatures for acid fruits, vegetables, and juices have usually been developed with the purpose of destroying or inhibiting the growth of microorganisms present in the food. With the exception of a few isolated foods and enzymes, little thought has been given to the effect of the process upon the enzyme systems involved, the assumption being that the enzyme systems are destroyed during the processing. Since it is known that enzymes play an important role in the deterioration of acid foods, the effect of heat processing on the principal enzyme systems of a representative group of acid foods was investigated. The investigation was further motivated by the possibility that the data obtained could be applied to the development of one of the enzyme systems as an indicator of adequate processing of canned acid foods.

As a result of this investigation a method has been developed for the determination of the thermal destruction conditions of the ascorbic acid oxidase and peroxidase of some acid foods that should find application in thermal destruction studies of the enzyme systems of other foods and biological systems. Thermal destruction curves of the enzyme systems studied follow a straight line within certain temperature limits when plotted on semi-logarithimc paper and are affected by some substances that are added to foods during canning. The processing requirements of time and temperature necessary to inactivate the peroxidase of experimental packs of acid foods processed under practical conditions can be accurately determined through the use of standard methods of process time determinations.

Influence of Food Ingredients on the Heat Resistance of Spoilage Organisms Encountered in Canned Acid Foods. (E. E. Anderson and W. B. Esselen, Jr.) Thermal death rate characteristics of suspensions of selected yeasts and bacteria were observed as they were affected by changes of the pH of the media from 3.0 to 7.0 and by various concentrations of salt (1 to 8 percent). At 140°F. the endpoint of destruction (99.99 percent) of a suspension of *Saccharomyces cerevisiae* occurred within seven minutes in McIlvaine's buffer at pH 3.0. At pH 7.0, 40 percent longer time was required to accomplish the same degree of destruction.

Salt (NaCl) added to tomato juice in concentrations ranging from 1 to 8 percent caused a definite drop in pH, amounting to 0.4 to 0.5 pH units in the case of 8 percent added salt. An increased rate of destruction at all test temperatures (200° to 220°F.) was noted for suspensions of *Bacillus thermoacidurans* in tomato juice with added salt, particularly that containing 8 percent salt, in which case 99.99 percent destruction at 212°F. was effected in 60 percent of the time required by control suspensions in plain tomato juice.

Sterilizing Value of Come-Up Time in Processing Home-Canned Foods. (J. E. W. McConnell, N. A. Vanasse, and W. B. Esselen, Jr.) Preliminary in-

vestigations have been carried on to determine the percentage of the come-up time which may be applied as process time for home-canned foods processed in a pressure canner at 240°F. The time required, after the completion of the venting period, for the pressure canner to reach the desired processing temperature was taken as the come-up time. Come-up times ranging from 0 to 60 minutes were studied. The test media used were 1 and 5 percent suspensions of bentonite, representing convection and conduction heating products, respectively. Pint home-canning jars were used as containers. With 1 percent bentonite suspensions, 30 percent of the come-up time was equivalent to process time at 240°F.; while 50 percent of the come-up time could be applied as process time in the case of 5 percent bentonite. The effect of the come-up time on the length of the process time was independent of the pressure canner load and of the rate of cooling in the jars.

Trimethylamine Production as an Indication of Spoilage in Fish. (C. R. Fellers, and D. Anderson.) The effect of temperature on trimethylamine production in samples of swordfish stored at 75°F., 40°F., and 32°F. was studied. Trimethylamine formation decreased with a decrease in storage temperature. A correlation of trimethylamine and ammonia formation was noted only at the highest storage temperature used. No correlation was observed between trimethylamine and bacterial content.

A method was perfected for obtaining sterile fish muscle press juice, which was used as a medium for determining that chemical autolysis occurring in fish muscle did not reduce trimethylamine oxide to the amine. Fifty microorganisms isolated from spoiled fish muscle were tested for the trimethylamine oxide reducing characteristic. Those microorganisms which reduced the oxide were identified as members of the coliform group.

Chemical dips of a 0.3 percent solution of sodium benzoate and a 0.2 percent solution of sodium nitrite inhibited the formation of trimethylamine. Acetic acid and sodium chloride dips did not affect trimethylamine amine formation in swordfish muscle.

Stability of Color in Fruit Juices. (J. E. W. McConnell, E. A. Nebesky, and W. B. Esselen, Jr.) The effect of length of storage, and the relationship of oxygen, light, sugar, pH, and ascorbic acid to deteriorative changes in the color of seven representative fruit juices (blueberry, currant, raspberry, tomato, grape, strawberry, and cherry) and strawberry fountain syrup have been investigated. Similar studies were made on solutions of purified anthocyanin pigments isolated from strawberries and currants to observe whether deteriorative changes in juices of these fruits were directly associated with changes in the pigment.

Temperature of storage and oxygen content were the agents most responsible for deterioration of color during storage of both juices and isolated pigments. Exposure to light caused little deterioriation of color in the juices, but exerted a measurable bleaching effect on the isolated anthocyanin pigments. Adjustment of pH values had little effect on deterioration of color in fruit juices, but some effect could be observed in solutions of isolated pigments. Sugar had little effect on stability of color in either juices or pigment solutions. The addition of l-ascorbic acid (50 mg. per 100 ml. of juice) had no protective effect on color stability with any of the juices except blueberry and grape. Addition of similar concentrations to strawberry anthocyanin, resulted in virtually complete decolorization of the pigment.

The Non-Enzymatic Browning of Foodstuffs. (W. B. Esselen, Jr., V. Lewis, and C. R. Fellers.) A study was made of some of the reactions that result in the

browning of foodstuffs. A method was evolved for the determination of carbon dioxide production in foodstuffs and in reaction mixtures. All foodstuffs examined produced carbon dioxide spontaneously on incubation. Some of the melanoidin pigments resulting from the reaction between glucose and glycine were isolated, and the degree of pigment production in this system correlated with carbon dioxide production. The Maillard type of reaction was not restricted to amino acids, but reactions of a similar nature were found to occur between glucose and carboxylic acids in general. Oxygen was found to be an important factor in the development of color, and sulfur dioxide was an effective inhibitor of browning. Color produced as a result of caramelization was insignificant as compared with the glucose-carboxylic acid reaction.

The Preservative Effect of Mustard on Fruit Juices. (S. G. Davis, Omer Kosker, and C. R. Fellers.) An investigation was conducted to study the preservative effect of mustard on fruit juices. Apple and grape juice were selected as test media and the relative effects of the active principles of common mustard seeds were investigated as well as of synthetic and natural oil of mustard. The minimum amount of mustard and mustard oil necessary for preserving the juices at varying temperatures was determined. The changes in chemical composition of the juices, as well as in their flavor and appearance, occurring under varying storage conditions were also investigated.

The inhibitory effects of mustard and mustard oil on typical spoilage organisms were determined by inoculating the sterile juice with typical spoilage organisms.

The active principle of mustard, allylisothiocyanate, had definite preservative effect on the fruit juices tested.

Processing Methods for Home-Canned Fruits. (Cooperative Project with the Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (W. B. Esselen, Jr., and N. W. Desrosier.) Heat penetration data on home-canned fruits obtained during the summers of 1945 and 1946 were analyzed, and a theoretical "run" representing the slowest heating and the fastest cooling characteristics was established for each of the following products, in pint and quart jars, for water bath and for 1, 5, and 10 pounds steam pressure processing: rhubarb, strawberries, cherries, raspberries, blueberries, peaches, apple sauce, tomatoes, and tomato juice.

Preliminary work showed that the use of pressure processing of fruit products significantly reduced the processing time required to yield a given sterilization value. The use of 1 pound steam pressure in place of water bath processing reduced the process times 25 to 35 percent, higher pressures decreasing the process to partial "come-up times." This is due to the lethality of temperatures over 212° F., when based on organisms with F_{212} of 1.0 or less.

Work with water bath processes showed that the use of high initial temperature (160°-170°F.) in comparison with temperatures in the range of 100°F. reduced the process times 50 to 75 percent.

The fruits processed under 1 pound steam pressure were organoleptically superior to those processed for greater periods of time in the water bath, both yielding the same sterilization value.

Home-Canned Baked Beans, Hominy, and Irish Potatoes. (Cooperative Project with the Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (W. B. Esselen, Jr., N. Vanasse, N. W. Desrosier, and A. Sizer.) Work is being carried on to obtain information on the process time requirements for home-canned baked beans, hominy, and Irish potatoes

packed in pint and quart glass jars and No. 2 and No. 2½ tin cans. During the past year data on heat penetration, inoculated pack, and thermal death time were obtained for these products. The work is being checked and expanded this year in order to have additional information upon which process times may be based.

DEPARTMENT OF FORESTRY AND WILDLIFE MANAGEMENT
R. P. Holdsworth and R. E. Trippensee in Charge

The Effects of Growth Rate and Wood Density of Plantation-Grown Red Pine on Certain of its Properties and Uses. (James M. Ring and J. H. Rich.) During the summer of 1947 field observations were made in 35 plantations of Red Pine located in New York, New Hampshire, and Massachusetts. Thirty-four samples of pole size were taken from eight of these plantations and one natural stand. Sections ten feet long were subjected to transverse bending tests, and the results were correlated with growth rates. The purpose of the study was to determine the feasibility of shortening the rotation without sacrificing the strength properties of poles.

Results obtained indicate that plantation-grown Red Pine which has made rapid growth during early life, and which has later slowed down forming a shell of dense growth has equally high strength, for use as poles, with Red Pine which has grown slowly from the beginning.

Spacing in plantations can be used to control rates of growth. It was further concluded that Red Pine grown in wide spacing producing low density cores results in stems more free of sweep and crook, and therefore more desirable for poles. This study was supported by the American Creosoting Company.

Gray Squirrel Damage to Lead-Covered Telephone Cables. (Paul A. White.) This work has been carried on since March 1946 and financied by the Bell Telephone Laboratories of New York.

The problem was to find the cause of gray squirrel damage to lead-covered telephone cable and if possible to find a way of preventing the damage. The research was carried on mostly with caged squirrels, but field checks were made in locations of damage, and data collected by the various telephone subsidiaries were analyzed and evaluated. The results of the study indicate that the attack on the cable is due to a nutritional disorder which is similar to the condition in cattle known as depraved appetite. This is caused by lack of calcium and phosphorus in the diet.

It is also possible that lead acts as a partial substitute for the calcium in the diet of the squirrels. The time of damage, of which there are two peaks, seems to indicate that the damage is related to pregnancy or lactation of the adult squirrels or to the time when the squirrel broods begin to feed for themselves.

Of the numerous repellents and cable protectors tried, Glass Fiber Cloth Tape seems to hold the greatest promise.

Pheasant Physiology. (Herman Goodell.) The purpose of this project was to determine whether a strain of pheasants could be developed to meet the needs of growers attempting to raise pheasants for meat.

Pure Mongolians and a Mongolian-Chinese ring-necked cross proved to be less nervous and slightly larger than straight Chinese ring-necked birds.

Sexing of day-old pheasant chicks was successfully accomplished. A pen of eight caponized males did not develop faster than did a pen of normal males handled under similar conditions.

No successful way was found to detect fast-developing birds through the inspection of plumage at an early age. There was enough variation between the development of different individuals to indicate that larger and faster growing birds could be produced.

Seeds in Relation to Rodents. (R. E. Trippensee.) The destruction of tree seeds by rodents prevents the establishment of stands of many trees, both softwoods and hardwoods, by direct seeding methods.

In this experiment, tests were run with pelleted pine and spruce seeds to which forty different chemicals had been incorporated as part of the series of coatings. The list of chemicals used can be furnished on request.

Concentrations of repellent substance varied from 1 to 5 percent. The trials were run with gray and red squirrels, chipmunk, and pine, meadow, house, and white-footed mice. The pelleted seeds were fed in special cages in which the feed was placed in a glass feeding receptacle. No other feed was available during the feeding trials. The test animals were given normal food after intervals of about three days.

These trials indicated that different rodents react differently, but in general none of the forty repellents gave much promise of protecting tree seeds from the rodents tested.

DEPARTMENT OF HOME ECONOMICS NUTRITION

Anne W. Wertz in Charge

The Effect of Certain Factors in Wilson's Liver Fraction L on the Utilization of Thiamine. (A. W. Wertz, L. E. Lloyd, and P. Shaw.) The widespread use of crystalline thiamine in the food-fortification program lends importance to the question of whether the utilization of thiamine may be influenced by other members of the vitamin B-complex. A norit eluate preparation which contained, in addition to pteroylglutamic acid, other factors in the vitamin B-complex was prepared from Wilson's Liver Fraction L. Albino rats fed this preparation stored more thiamine in their tissues than their pairmates which did not receive the eluate preparation but were fed identical amounts of thiamine. The urinary output of thiamine and pyruvic acid did not differ significantly in the two groups. These facts indicate that there was some factor present in the norit eluate preparation that influenced the storage of thiamine in the albino rat. Work is continuing on this project in order to determine, if possible, the factor responsible for this effect on thiamine.

The Effect of Pteroylglutamic Acid on the Appetite and Growth of Thiamine-deficient Rats. (P. Shaw and A. W. Wertz.) Preliminary work indicates that pteroylglutamic acid stimulates the appetite and growth of rats fed a thiamine-deficient ration. The rats fed pteroylglutamic acid consumed their food in a much shorter time and maintained their weight at a higher level than their littermate controls not receiving this vitamin. Further work is in progress on this problem.

The Effect of Alcohol Consumption on the Utilization of Thiamine. (L. E. Lloyd, P. Shaw, and A. W. Wertz.) The similarity between alcoholic polyneuritis and the polyneuritis caused by thiamine deficiency suggests the hypothesis that

the metabolism of alcohol in the body increases the need for thiamine. An experiment was designed to test this hypothesis, using albino rats as the experimental animal. Results indicate that the tissues of the rats receiving a daily supplement of alcohol contained more thiamine per gram than the tissues of their littermate controls which were fed an iso-caloric ration containing the same amount of thiamine but no alcohol. Also, the group receiving the alcohol excreted less pyruvic acid in their urine than the controls. These facts indicate that the rats receiving the alcohol were in a better state of thiamine nutrition than the rats not fed the alcohol, and that the consumption of alcohol did not increase the need for thiamine. Work is continuing on the project.

The Nutritional Status of Pregnant Women. (A. W. Wertz, P. Shaw, M. E. Lojkin, and E. Morse.) This project is being carried out in cooperation with the Northeast Regional Cooperative Project, Studies in Nutritional Status, and with the cooperation of Dr. E. M. Holden of Amherst. An attempt is being made to determine the nutritional status of pregnant women by studying their dietary habits and physical condition, and the quantity of certain nutrients in their blood and urine. This project is also concerned with the determination of the most suitable methods for use in studies on nutritional status. This project is to be continued for approximately three years. No results are as yet available.

The Amount of Certain Nutrients in the Cord Blood in Relation to the Amount of these Nutrients in the Pre-natal Maternal Diet. (A. W. Wertz, M. E. Lojkin, and P. Shaw.) This project is being carried on with the cooperation of Dr. E. M. Holden of Amherst. At parturition samples of the cord blood are obtained and the serum analyzed for protein, ascorbic acid, thiamine, riboflavin, niacin, vitamin A, and carotene. The amounts of these nutrients found in the serum are compared with the amounts present in the pre-natal maternal diet and any correlation noted.

The Validity of the Values in Food Composition Tables for Use in the Calculation of Nutrients in Specific Diets. (M. E. Lojkin, P. Shaw, E. Morse, and A. W. Wertz.) Food composition tables are used extensively for the calculation of the adequacy of dietaries in respect to specific nutrients, especially vitamins and minerals. As these tables are compiled from experimental results obtained all over the United States, it is pertinent to know whether the tables are valid for calculation of dietaries in Massachusetts.

A composite sample of a day's food intake is analyzed in the laboratory for protein, fat, thiamine, riboflavin, niacin, ascorbic acid, vitamin A, carotene, calcium, phosphorus, and iron. The analytical results are compared with the values obtained by calculation of these nutrients from the table of food composition. The degree of agreement or discrepancy in the figures is noted. A suitable number of dietaries will be analyzed in order that statistical methods may be applied in the interpretation of the result.

Rodenticide Investigations. (L. R. Parkinson.) Studies are under way to investigate the reason for the variation in the resistance of rats to red squill. Early results indicate that this variation may be due largely to the nutritional status of the rats. Heredity may also be an important factor. The apparent seasonal variation in the toxicity of alpha-naphtha-thio-urea (ANTU) is also being studied.

DEPARTMENT OF HORTICULTURE

Clark L. Thayer in Charge

Study of Herbaceous Perennial Material. (C. J. Gilgut, Waltham.) The test garden of herbaceous perennial flowering plants was visited throughout the season by many people from Massachusetts and from other States. It will remain in its original location now that another site has been chosen for the proposed new laboratory and administration building.

A good blanket of snow, soon after the ground froze in the fall and during the winter, protected the plants so that few were lost by winterkilling. Some replacements of plants lost for various reasons, and of old varieties superseded by newer and more desirable varieties in the trade, have been made; but much more replacement needs to be done, especially of Hemerocallis. Already a good start has been made on a collection to include in this group of plants the newer colors such as reds, pinks, apricots, and bicolors, and also plants of better habit and more garden value.

A buyer of phlox plants at present has no assurance that he will receive true to name or even good phlox. On one order of eight named phlox from a mail order nursery doing business nationally, six plants were the same—a worthless, small-flowered, magenta-colored scrub seedling. Similar mixtures and also misnamed plants have been received from other nurseries.

The Delphinium collection has been augmented by addition of several strains and by selections from our own plantings.

Foliar nematode is a serious pest of outdoor chrysanthemums and the effectiveness of sodium selenate in several forms, varying dosages, different methods and time of application, as well as spraying at weekly intervals with wettable DDT powder were tested. The results were inconclusive and the test is being repeated this year.

Control of Weeds in the Nursery by Chemical Sprays. (C. J. Gilgut, Waltham.) Sovasol No. 5 was found to be a more desirable and effective weed-killer in the nursery than 2,4-D ester formulations (Weedone, Weed-no-more 40, Weeded, and Esteron) or the ammonium and sodium salts of the 2,4-D acid with which it was compared. It killed grass and other weeds quickly and, when properly controlled so that the spray did not strike nursery plants, caused no injury. Concentrations of 2,4-D necessary to kill grass caused delayed injury to nursery plants, sometimes serious, from direct spray as well as from drift of vapors of the volatile ester formulations, especially in hot weather.

Early-season applications of Sovasol No. 5, when weeds were 4 inches high or smaller, often gave weed control for as long as six weeks. In several cases two or three applications were sufficient for the season, but in most cases applications were needed at intervals of about four weeks. Late March and early April applications, when temperatures were 60° F. or less, gave good weed kill but not as good nor as quick as later in the season when temperatures were above 70° F.

In a nursery block of large plants, 5 to 6 feet high, large weeds were killed by first scything and then spraying with Sovasol in hand sprayers at one-third the cost of hoeing.

Spraying rows of gladiolus corms and cormels at the first sign of emergence of shoots through the soil gave excellent results and eliminated the first hand weeding. The spraying was done with a 3-gallon pump-up hand sprayer, and the spray applied at a moderate walk, as compared with hand weeding done tediously and always on hands and knees. Hand weeding was necessary after the plants were up because gladiolus is easily injured by Sovasol.

Factors Influencing the Rapidity of Growth of Nursery Stock. (C. J. Gilgut, Waltham.)

Rhododendron Leaf Bud Cuttings. Leaf bud cuttings of *Rhododendron roseum elegans* taken in November rooted 87 percent by May, of which 58 percent had very good roots; 16 percent good, and 13 percent fair. Lined out in the field, these plants have grown to fine salable 2-foot plants in three years. Best rooting was of cuttings from firm current wood treated with Hormodin No. 2 powder and placed in horticultural peat moss or Sanisoil (shredded redwood bark). Care was taken that the peat moss was kept moist but not wet. Other highly desirable varieties of named evergreen rhododendrons did not root well under combinations of conditions and treatments tried.

Effect of pH, Nitrogen, Phosphorus and Potassium on Growth of Yews. The preliminary work was carried on in pots in the greenhouse and treatments were as reported in 1947. This year the same treatments were given plants in the field. As yet there are no clear-cut results.

DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

Asparagus Investigations. (Robert E. Young, Waltham.) The year's results with the second generation lines of asparagus breeding material showed a continuation of the biennial bearing effect reported in 1946. The crop was very poor, being 25 percent below that of the previous year but only 6 percent below that of 1945. The relationship between the selected strain and the commercial strain remains the same as previously reported. No rust appeared on any of the plants.

The nineteen strains and varieties of asparagus that make up the third generation planting were cut for the first time for two weeks in 1947. Although the cutting period was short, the yield, comparatively considered, was good. The best strain produced .36 pounds of asparagus per plant. The yield of the two commercial strains was only half of this. There was a similar range in the size of spears, from 19 to 28 per pound. While the highest yielding strain happened to be the one producing the largest spears, in general there did not seem to be a very close relationship between size of spears and yield. The strains which produced small spears came from parents that had a record for high yield but small spears.

There existed a good relationship between the number of stalks produced in the summer and the number of spears harvested. The relationship between the stalk counts and weight of spears was not as good as in previous crops.

Only 14 plants died during the year as compared with 46 the previous year. Some strains still have 100 percent plants while others have lost as many as 15 percent. This seems to be an hereditary character.

Vegetable Breeding for Improvement of Quality. (Robert E. Young, Waltham.) During the year breeding work was conducted with broccoli, celery, New York type lettuce, greenhouse tomatoes, trellis and field tomatoes, carrots, cabbage, and Butternut squash. Progress has been made in the development of strains of lettuce and cabbage better adapted to local use. Work was along the lines previously indicated, but new developments are not conclusive enough to warrant detailed report at this time.

Carrots.—During the year a search was made to find a carrot variety which would have better color than the Hutchinson but still retain the strong top, resistance to carrot blight, and, of course, the long slim root. Fifty different varieties and strains were collected from many seedsmen in both the United States and Europe. These varieties were grown as spring, summer, and fall crops.

The nine varieties obtained from Europe either were too short or produced light-colored roots. The various strains of Imperator, which is the variety grown in the West, produced a weak, small top when grown in New England. In our soil the roots of this variety are not as long as those of Hutchinson. The color is good but the tops are very susceptible to carrot blight. All of the other varieties failed to meet the standard in one way or another.

Since no variety was found to replace the Hutchinson, the breeding program to produce better-colored roots, which has been under way, will be enlarged and intensified. Roots that most nearly fit the standard were produced from material that came from crosses of Hutchinson and Turkey Red or Imperator. Considerable testing is necessary to determine adaptability, resistance to disease, and market acceptance.

Broccoli.—Spring and fall broccoli trials again indicated that Waltham No. 7 is suited for planting in the spring, while strain No. 29 must be grown in the fall so that the plant can develop during warm weather. Waltham No. 11 has proved adaptable for both spring and fall growing.

During the late fall of 1947, the weather was such as to demonstrate the value of strain No. 29. It is slow growing and does not easily push up to flower. Production averaged slightly more than 1 pound per plant.

There was wide variation among the many varieties in the trials to freezing damage. On some varieties 70 percent of the crop cut November 3, 1947, following a sharp freeze, was unmarketable; Waltham No. 11 had 55 percent not marketable; and Waltham No. 29 only 22 percent. This hardiness factor is important since the harvest continues well into late fall.

In 1948, cold wet weather for several weeks following transplanting of the spring crop to the field caused the plants to produce a small button of a head before obtaining their proper size. Subsequent warm weather caused these small buds to push up rapidly, forming either a worthless head or one only about one-fourth the usual size. This is the first time in ten years that the weather has been so adverse as to affect almost all varieties and strains. Waltham No. 7 made the most rapid recovery and proved the best. In 1947 it produced 1.1 pounds marketable broccoli per plant and this year only 0.77 pound. Waltham No. 11 produced 1.0 and 0.62 pound respectively for the same periods.

Celery.—The fifth generation of plants from a cross between Summer Pascal and Cornell No. 19 was grown. Fifty single-plant selections from the 1945 crop were tried. Along with these were trials of stock seed lots of our strain of Summer Pascal, and Summer Pascal from various seedsmen as well as new varieties recently introduced.

None of the new varieties was as good as Summer Pascal under our conditions. From the breeding material, four lots of green and one of semi-green proved sufficiently good to warrant further trial.

On some types of soil Summer Pascal has been too short, and one selection was made of a taller type to fit this need. One selection was made on the basis of its performance in the hotbed where the crop is left for early maturity. The other two have other points of superiority over Summer Pascal. Trials over several years are necessary to prove adaptability.

Trellis Tomatoes.—In order to bring the highest prices on the Boston market, tomatoes must have the following characters: (1) firmness, not only while ripening but when completely ripe; (2) smoothness and uniform size; and (3) uniform, deep red color. Not only do tomatoes with these characters meet with acceptance in Boston, but other New England cities and New York City have paid premiums for such fruit.

Trials of tomato varieties and hybrids have been judged with the firmness character in mind. Results indicate that many hybrids, while satisfactory in other respects, do not meet the firmness requirement. Crosses between Trellis No. 22 or Waltham Forcing and such varieties as Bonny Best, Stokesdale, Earliana, and Pritchard produced fruit that was too soft. Red Cloud, Harkness, Michigan State Forcing, and Quebec No. 5 have proved fairly satisfactory as parents.

The average early yield (first three pickings) of 10 hybrids was 3.94 pounds per plant compared to 2.78 from Trellis No. 22. Where the plants were not trellised but grown flat, the hybrids showed to better advantage. Trellis No. 22 X Red Cloud produced 5.91 pounds of fruit per plant compared to 2.39 from Trellis No. 22. This hybrid is probably sufficiently firm to satisfy the market.

Two new varieties showed to sufficient advantage to warrant recommending them to growers for trial. These are Quebec No. 5, from Laval University, Quebec, and Early Trellis, a sister selection of Trellis No. 22.

Waltham Scarlet, a variety for the home gardener and roadside stand operator that was released last year, proved to be earlier than in previous trials, being equal to Trellis No. 22 when trained up and 75 percent as good when grown flat. Total yields under both methods of culture were about equal to those of Trellis No. 22. Its advantages are larger size and better interior color and texture, while still retaining most of the firmness of Trellis No. 22.

Greenhouse Tomatoes.—A spring crop of greenhouse tomatoes was grown for comparison of Waltham Forcing with other varieties and hybrids.

A hybrid between Waltham Forcing and Michigan State Forcing produced 10 percent more fruit than the Waltham Forcing. While this increase in yield is sufficient to justify continued interest and trial, the fact that 33 percent more of the fruit graded No. 1 is more impressive. At prevailing Boston Market prices, cash returns amounted to $2.39 per plant for the Waltham Forcing and $3.06 for the hybrid.

The hybrid had larger fruit, requiring 4.84 to weigh one pound as compared with 5.38 for Waltham Forcing, and more vigor, and the plants remained greener than the Waltham Forcing. Limited trials in growers' greenhouses have aroused favorable comment, and seed production will be increased so more extensive trials can be made. More information is also being obtained about the cost of producing the hybrid seed.

Butternut Squash.—During the year a crop of Butternut squash was grown in the greenhouse in an effort to make up for the small number of selfed fruit obtained in 1946. This crop was grown on trellis, in the same manner as cucumbers, and produced very satisfactory fruit. Even though seed was started on February 15, only a part of the crop had matured by May 25, the time for planting seed outside.

The summer crop was satisfactory as regards yield, with the best strain producing over 500 boxes per acre. Insufficient data were obtained from many lines because of inadequate stand. It was necessary to replant some rows because of failure of greenhouse-grown seed. Planting June 15 reduced the tota

yield 16 percent, and the yield of No. 1 squash 8 percent, and there was a slight reduction in the number of culls, also of cracked squash. The late planting increased the percentage of crooked squash from 6.4 to 12.4 percent.

An analysis of the data indicates a complex interrelationship between the percentages of the various grades the strains produced and the weather during the growing season. In 1946 the average percentage of cracked squash was 17.1, and in 1947, 25.8 percent.

Inbred lines are being obtained that have one and sometimes two desirable characters fairly well fixed.

Storage tests were made of all inbred lines in search of material that would have lower weight losses in storage and keep for a longer time. None of the lines kept significantly better than others. Some squash within all lines kept until January 15. The average loss in weight in this period was 22 percent, not counting the loss due to disease. When the squashes were waxed with a wax emulsion, the loss in weight was reduced 45 percent. The loss in weight was further reduced (30 percent) when the squashes were wrapped in pliofilm. The wrapping was done not as a practical method of storage but as a means of investigating weight loss.

Breeding Sweet Corn, Peppers, and Field Tomatoes for Massachusetts. (William H. Lachman.)

Sweet Corn.—Approximately 4,000 plants were self-pollinated during the year to further stabilize inbred lines in the process of development and to increase the seed supply of lines that are homozygous. Two crops were grown in the greenhouse in an effort to speed up the program and while the fall crop was not satisfactory the early spring crop was quite successful. With supplementary artificial lighting, a crop has been grown early in the spring for three years. It is true that inbreds do not mature in their proper season in relation to one another when grown indoors but sufficient benefits have resulted from this process so that the work has been greatly facilitated. One large seed producer in Idaho has cooperated in testing our inbreds in the production area, which has also proved to be a valuable adjunct to the project.

Ten extra early inbreds are now ready for testing in hybrid combination. These have been produced through back-crossing extra early types with later, more desirable, market types. A program of eventually combining sixteen superior inbreds into one hybrid has also been initiated. When this has been accomplished the potential mixture of germ plasm should provide some very desirable types upon self-pollination.

Several hundred experimental hybrids were grown and studied as to their general adaptability for this area. Thirty-two of these were noted as being desirable and will be included for further study.

One outstanding hybrid named Pilgrim has been introduced to the trade. This is produced by crossing Massachusetts 32 with Connecticut 27, is midseason in maturity, and the plants produce an excellent yield of large attractive ears. Approximately twelve tons of seed were sold by seedsmen to farmers for production this year.

Two new hybrids will be released in 1949. One is an extra early sort resulting from a cross of Connecticut 3 and Massachusetts 2410-191. The other is a second-early, high-quality variety resulting from crossing Massachusetts 2412-2 x 2412-1 by Maine 2.

Peppers.—The production of sweet peppers is greatly hampered in this area by the poor setting of fruits among the standard varieties. Serious infestations

of tobacco mosaic also take their toll. Several strains of Worldbeater have shown themselves to be resistant to this disease but they are variable within these strains as to productiveness. A number of single plant selections appear to have considerable merit. Seed is now being increased so that they may be sent out for trial.

Tomatoes.—A number of F_1 hybrids introduced by seedsmen and experiment station workers indicate that this type variety may have considerable merit. One of the hybrids developed and tested here, Pennheart by Firesteel, performed exceptionally well in the trials last year. Several selections now in the F_6 generation from a cross of Bounty by Stokesdale also look very promising. One of the lesser known varieties, Firesteel, and selections from this variety were among the best of the early varieties. These plants were especially prolific and the fruits were large, solid, and smooth.

Weed Control in Vegetable Crops. (William H. Lachman.) The use of Stoddard Solvent as a weed control agent in fields of carrots and parsnips is now considered standard practice by commercial vegetable growers. There is a tendency to apply this material rather late in development of these crops with the result that a rather severe necrosis develops in the crown of the roots. This is particularly disturbing since these roots do not keep well in storage.

The results from studies designed to find selective weed killers for set onions have been most promising. Recently some investigators have recommended the use of a .5 percent solution of sodium pentachlorophenate for this purpose. This material was not effective in killing annual grasses, however, and the yields from these plots were the lowest among the treatments. Dinitro compounds such as Sinox and Dow Selective Herbicide were also ineffective in controlling annual grasses but did not damage the onion tops as much as the previous treatment. The yields from these plots were also significantly lower than those from the cultivated plots. Plots in which the weeds were controlled with a hand weed burner also yielded less than the checks, although not significantly so. Good weed control but with rather severe damage to onion foliage resulted from several applications of Aero Defoliant Chemical Dust (Cyanamid) at the rate of 60 pounds per acre. The average yields from these plots were also lower than from the checks although the difference was not significant. Some preliminary work with Aero Cyanate Weed Killer (potassium iso cyanate) indicates that this material is well adapted as a weed killer in the culture of onions. It is relatively harmless to onion foliage in low concentrations (1 to 2%) and is toxic to most small weeds until they have developed to about ¾ inch high. Lamb's quarters is especially resistant to this material after it has passed the cotyledon stage.

Isopropyl n-phenyl carbamate at the rate of 5 pounds per acre was particularly effective in controlling annual grasses in a late summer planting of spinach and beets. Overwintered spinach on these plots was completely free from chickweed whereas the check plots were badly infested with this weed. In a cooperative experiment with one vegetable grower isopropyl n-phenyl carbamate at the rate of 5 pounds to the acre was very effective in controlling chickweed in a planting of early spring lettuce.

Pre-emergence application of No. 2 fuel oil prevented the growth of weeds in sweet corn for a period of 5 weeks. 2, 4-D, in pre-emergence applications to fields of sweet corn at rates of 1½ to 2 pounds per acre, was particularly effective in preventing growth of weeds except for smartweed which is apparently very resistant to this treatment. Post-emergence applications of 2, 4-D were ineffective in controlling grasses. Pre-emergence applications of Dow Contact Weed

Killer at the rate of 2 to 3 gallons per acre were very effective in controlling weeds in fields of sweet corn as well as snap beans. Granular cyanamid at the rate of 600 pounds per acre prevented weed growth in sweet corn for about 4 weeks.

The Culture and Nutrition of Vegetables. (William H. Lachman.)

1. Tomato plants mulched with manure produced fruits higher in soluble solids, nitrogen, and phosphorus than those mulched with straw or sugar cane fiber or unmulched. Plots mulched with sugar cane fiber produced lower yields than any of the other treatments, but fruits from these plots were highest in total sugars, carotene, ascorbic acid, calcium, phosphorus, and potassium. The soil in the plot mulched with manure was in the best physical condition, and the organic matter and nitrogen were higher than in the other treatments. (In cooperation with Dr. Holmes of the Chemistry Department.)

2. Defoliation in determinate varieties of tomatoes such as Pennheart is very serious just as ripening of the fruit begins. Through experiments with varying degrees of blossom removal at anthesis, it was found that an inverse relation exists between fruit load and retention of the foliage.

3. A chlorotic condition found on the older leaves of greenhouse tomato plants has been diagnosed as magnesium deficiency. Experiments using soil known to be deficient in magnesium indicate that this chlorotic condition may be alleviated by applications of magnesium sulfate or dolomitic limestone. More response from this treatment results if it is combined with a heavy application of manure. Applications of potash aggravate the chlorotic symptoms.

4. The use of a plant hormone applied as a spray was effective in increasing the early set of tomatoes. Fruits set well on flowers that had been emasculated before anthesis and were entirely seedless.

5. Automatic surface watering of greenhouse tomatoes has a distinct possibility but the proper level of soil moisture content has not been determined. A layer of sand about one inch deep on the surface of the soil was found to be of value in distributing water laterally over and through the beds.

DEPARTMENT OF POMOLOGY

A. P. French in Charge

The Influence of Various Clonal Rootstocks on Apple Varieties. (W. D. Weeks and F. W. Southwick.) Although frost reduced the 1947 crop in the large stock-scion orchard, the crop was the largest to date. Eight-year-old trees of Red Spy on Malling II averaged over a bushel of fruit per tree, while trees on Malling XVI averaged less than one-tenth bushel. In general, the yields of other varieties were greater on Malling I and II than on other stocks.

Seeds of two ornamental type crabapples, *Malus sikimensis* and *Malus toringoides*, which show promise as rootstocks, were obtained from the Arnold Arboretum. Seedlings of these will be budded to several commercial varieties for testing as to their value for root-stocks.

Lethal Incompatibilities Between Clonal Stocks and Varieties of Apples. (W. D. Weeks.) More evidence was obtained to show that the lethal factor in McIntosh strain R can be transmitted to the congenial McIntosh strain G. It was also demonstrated that the lethal factor in strain R does not depend on

any material manufactured in the leaves. Spy 227 stock budded to strain R buds which were sheared off in November died in typical fashion the next summer. Although the trouble appears to be caused by a virus there is no evidence that it can be transmitted except by budding. New combinations of varieties or strains budded on Spy 227 reveal that Red Spy, Foster Gravenstein, Whitcomb Gravenstein, Mead Gravenstein, Rhode Island Greening, Baldwin, and Galbraith Baldwin all died in typical fashion; while Northern Spy, Milton, Kendall, Early McIntosh, and Macoun made normal growth. A paper will be published in the Proceedings of the American Society for Horticultural Science.

Magnesium Deficiency in Massachusetts Apple Orchards. (W. D. Weeks.) Leaf samples for chemical analysis were taken again during 1947. Analyses of the 1946 samples indicate that mature apple trees which had received 30 and 60 pounds of magnesium sulfate per tree did not have their magnesium content increased appreciably over check trees. The low magnesium content of the leaves of the 1946 samples indicates that many of these trees were deficient in magnesium but they failed to show any typical deficiency symptoms during the growing season. Analysis of the 1947 samples is not complete at this time so we do not know whether heavy soil applications of magnesium sulfate have been successful in increasing the magnesium content of mature apple trees. No typical magnesium deficiency symptoms were observed on these trees during the 1947 season.

Influence of Chemical Treatments on Flowering and Fruiting of Fruit Trees. (F. W. Southwick and W. D. Weeks.) Chemical thinning tests were conducted at Amherst and in three commercial apple orchards using the dinitro materials (DN#1 and Elgetol) at blossom time and the sodium salt of naphthaleneacetic acid (App-L-Set) at calyx time and two and four weeks after calyx. One test on Halehaven peaches was conducted using three dinitro materials (DN#1, DN#289, and Elgetol) at blossom time.

Although the bloom was heavy, the weather, except for the first two or three days when apple flowers commenced to open, was not conducive to a heavy set. During the bulk of the blooming period cool, rainy weather limited the extent of pollination. Under these conditions the set was not nearly as great as the bloom indicated it might be. Elgetol applied to Red Astrachan, Baldwin, and Duchess resulted in much more thinning and foliage injury than similar single or double applications of DN#1. Where the set was heavy enough to warrant thinning on Yellow Transparent, Wealthy, Duchess, and Early McIntosh, DN#1 gave satisfactory results. It no longer seems desirable to consider the liquid dinitro materials for blossom thinning of apples. In the peach test DN#289 reduced the set more than equivalent concentrations of either DN#1 or Elgetol.

Applications of 8 ounces of App-L-Set per 100 gallons of spray at calyx time eliminated the crop on Duchess apple trees and resulted in severe leaf dwarfing and distortion. Calyx applications of this material to Wealthy, McIntosh, and in some instances Early McIntosh, thinned satisfactorily at calyx time with much less foliage injury. App-L-Set appears to be more injurious to apple foliage when applied shortly after bloom than when used at the same or higher concentrations two and four weeks after calyx. Tests at Amherst and in one grower's orchard, using up to 16 and 20 ounces of App-L-Set per 100 gallons of spray four weeks after calyx on McIntosh, Golden Delicious, and Early McIntosh, show that chemical thinning can be accomplished at this late date. A treatment that can be made as late as four weeks after calyx has a distinct advantage over bloom or calyx applications, since the extent of fruit setting and the necessity for thinning can be rather accurately determined by that time. Of course, the

earlier thinning can be done the greater are the chances of obtaining desirable commercial size with the least reduction in yield and of making alternate-bearing varieties bear more uniform annual crops.

The Nature of Winter Hardiness in the Raspberry. (J. S. Bailey and A. P. French.) By bringing raspberry canes into the greenhouse during the winter and observing the rate at which they started into growth it was found that the raspberry had a very short rest period and that there were varietal differences. This suggested that there might be a relationship between the length and intensity of winter rest and cold resistance.

To test this possibility canes of six varieties were brought into the greenhouse at regular intervals during three winters. The varieties Chief and Latham were selected as cold-resistant varieties, Marcy and Washington as tender varieties, and Milton and Taylor as intermediate in cold resistance. It was found that the cold resistant varieties go into a deeper rest and come out more slowly than the tender varieties. A report on this work will appear in the Proceedings of the American Society for Horticultural Science.

The raspberry planting used in this work was set in the spring of 1942. The planting was divided in half. One half was given a heavy mulch of hay or straw, whichever was available, and additional mulch added annually. The other half is cultivated with a cover crop sown in midsummer. These plots were subdivided, making a total of four plots. One mulched plot receives no additional nitrogen and the other $NaNO_3$ annually at the rate of 225 pounds per acre. One of the cultivated plots receives $NaNO_3$ annually at the rate of 225 pounds per acre, the other at the rate of 450 pounds. Until the winter of 1947-48 there was no indication of differential winter injury between the mulched and cultivated plots. During the winter of 1947-48 there was definitely more winter injury on the mulched plot.

Since the type of mulch used results in high soil nitrates, it was thought that nitrogen supply might be a factor. However, when the data were broken down according to the four plots varying in nitrate application, there was no relation between winter injury and the amount of $NaNO_3$ applied.

During the winter of 1947-48, freezing tests were made to determine the rate of hardening of raspberries. The only low-temperature rooms available were in a large room held at 0° F. for storing frozen foods and in a sharp freeze room ordinarily held at −15° F. Canes of the Chief and Latham varieties were used to represent cold-resistant varieties and canes of Marcy and Washington to represent varieties lacking cold resistance. On November 18 and December 1 canes of all four varieties were severely injured by 24 hours' exposure to 0° F. On January 13, following a period of several days with temperature near 32° F., sudden exposure to 0°F. resulted in less injury than in previous tests. By shutting off the ammonia and opening the door, the temperature in the sharp-freeze room was raised to 30° F. Lots of canes were placed in the room and the door shut. The temperature dropped to +9° F. in one hour and fifteen minutes and to +7° F. in 24 hours. This treatment resulted in slightly less injury than sudden exposure to 0° F.

Another lot of canes was brought in for test February 19. At this time there was evidence that injury had occurred outside. Exposure to 0° F. caused some injury, but the difference between treated and check was not great because of the injury which occurred before the canes were brought in. Exposure to 0° F. caused less injury than earlier in the season. The hardy varieties, Chief and Latham, withstood the temperature drop better than the tender varieties, Marcy and Washington.

Chemical Control of Weeds. (J. S. Bailey.) In 1946 and 1947 it was found that ammonium sulfamate and a proprietary weed killer containing sodium chlorate and a deflagration agent could be used around apple trees four years of age to control weeds. A report of this work appeared in Vol. 51 of the Proceedings of the American Society for Horticultural Science.

To see whether these materials could be used around year-old apple trees and how much, applications were made in August, 1947. Ammonium sulfamate was used at ¾, 1½, 3, and 6 pounds per gallon and the proprietary mixture at 1, 2, and 4 pounds per gallon. One gallon of each concentration was sprayed in a circle about 6 feet in diameter around a tree. Treatments were made in quadruplicate.

Ammonium sulfamate at 6 pounds per gallon caused the trees to lose all their leaves in the late summer of 1947. A new crop of leaves started to appear later but these trees all died during the winter. The other concentrations caused a dwarfing of the trees roughly proportional to the amount used. Also, they caused in 1948 a chlorosis of the leaves which varied from a yellowing of the margins to a yellowing of the entire leaf.

One and two pounds of the proprietary mixture caused a slight dwarfing of the trees. Four pounds caused considerable dwarfing.

Since a circle 6 feet in diameter contains an area of about 28 square feet, the quantity of each concentration applied was nearly four times the amount which would ordinarily be used.

All concentrations of both materials killed all weeds including quack grass (*Agropyron repens*). A considerable growth of clover and some annual weeds in 1948 indicate that the soil was not sterilized for any great length of time.

In the spring of 1947 experiments were started on the control of weeds in strawberry beds with 2,4-D. A comparison was made between 2,4-D acid put in solution with Carbowax 1500, the sodium salt of 2,4-D, and an ester formulation. The ester formulation appeared to be too toxic to the strawberry plants. The 2,4-D acid and the sodium salt appeared about equally effective in the control of broad-leaved weeds and the effect on the strawberry plants was slight and temporary. The sodium salt is much easier to put into solution.

In the spring of 1948 these experiments were continued and expanded. One series of plots was laid out in a renovated bed where the sodium salt of 2,4-D, isopropyl-N-phenyl carbamate, dinitro-ortho-secondary-butylphenol, phenyl-mercuri acetate, Stoddard solvent, and some combinations of these are being tried. Another series of plots was laid out in a newly set bed where the sodium salt of 2,4-D, isopropyl-N-phenyl carbamate, phenyl-mercuri acetate, phenyl-mercuri triethanol ammonium lactate, and ammonium sulfamate and combinations of some of these are being tried.

Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction. (J. S. Bailey.) Leaf symptoms, which were very similar to those produced in sand cultures by withholding magnesium, appeared on a few of the blueberry bushes in the University planting at Amherst. In order to find out whether this was magnesium deficiency and whether or not it could be corrected by application of magnesium, a series of plots was laid out on some of which magnesium sulfate at 500 pounds per acre was broadcast on the soil and on others it was sprayed on the plants.

Leaf samples were obtained from these plots before and after treatment and from normal appearing bushes in the Cape Cod section. These samples were analyzed for P, K, Mg, and Ca by Mr. C. Tyson Smith of the Feed and Fertilizer Control Service. Compared with apple leaves, the content of P, K, and Ca was

low, but Mg was not dangerously low. From July to September Ca increased, K increased in some cases and remained about constant in others, Mg changed little, if at all, and P decreased in some cases and remained about constant in others.

Blueberry Culture. (J. S. Bailey.) The spraying experiments for the control of mummy berry were continued through 1947. Bordeaux mixture was not effective in controlling this disease. Fermate alone gave some control, but best results were obtained when Goodrite p.e.p.s., a spreader and sticker, was added to the Fermate. P.e.p.s. alone appeared to have a little fungicidal value. A report of these results will appear in the Proceedings of the American Society for Horticultural Science. In the spring of 1948 diligent search for mummies producing apothecia was made on numerous occasions. Only one such mummy was found although numerous mummies in apparently good condition were present. In spite of the apparent absence of apothecia, a considerable number of infected berries appeared in early summer. Because of severe winter injury and the prospect of an extremely small crop, plans for continuing the spraying experiments in 1948 were abandoned.

In the spring of 1948 a commercial test of a dormant application of D-542 was tried for the control of a Lecanium scale. It appears to be effective and safe. A dormant application of D-289 was effective in controlling the scale but was very toxic to the blueberry bushes.

In July, 1947, several bushes of the varieties Cabot and Pioneer which were covered with bindweed were sprayed with the sodium salt of 2,4-D at 1,000 ppm. This one application killed the tops of the bindweed but some regrowth occurred late in the season. In the summer of 1947 there was no evidence of injury to the blueberry bushes except a slight twisting of some of the new shoots. However, in the spring of 1948 there was slight evidence that the sprayed bushes were winter injured more than adjoining unsprayed bushes.

Although the blueberry stunt disease has been present in Massachusetts for a number of years, no indication of its spreading was found until the summer of 1947. At that time evidence was found that it was spreading slowly in Plymouth County. In the early summer of 1948 a Grover bush definitely infected and a June bush which looks suspicious were found in the University planting at Amherst. These are definitely new cases and show that the disease is spreading here, too.

There are 20 U.S.D.A. selections in the University planting. Ten of these were set in the spring of 1948. Of the other ten, five, which were budded on Rubel stocks several years ago, have fruited. Of these five V-20 looks the most promising. GN-87 looks good enough to warrant further trial. F-72, R-86 and U-85 are of doubtful value.

Studies of Varieties of Fruits. (W. D. Weeks and Staff.)

Apples.—Galbraith Baldwin, a red sport of Baldwin, which originated in one of the experimental blocks, was introduced to growers and 16 eastern nurseries for their consideration. This strain shows considerable promise and both growers and nurserymen are anxious to obtain propagating wood of it.

A bud sport of McIntosh, obtained from Roger Kimball of Littleton, has been found by federal workers to be a tetraploid and offers promise as a parent for breeding.

Peaches.—The following varieties have been dropped from the trial list:

Hardee is not outstandingly hardy under Massachusetts conditions, and the fruit is unattractive in shape, color, and general appearance, and is poor in texture and flavor.

Duke of York is too small, too poor in quality, ripens too unevenly and is clingstone. It has nothing but earliness to recommend it and cannot compete with other varieties of its season.

Fisher has not been outstandingly hardy. The fruit ripens very unevenly, sometimes at one end first, sometimes on the outside, leaving the center hard and underripe. The quality is variable and no better than fair at its best.

Champion, although it has many fine qualities, has flesh which is too soft for shipping. Even for the back yard better varieties are available.

Polly is almost an exact duplicate of Champion. Like that old variety, it has many good qualities but the flesh is too soft.

Blueberries.—Among the U.S.D.A. blueberry selections which have fruited, V-20 looks the most promising. The berries, which ripen late midseason to late, are large and fine flavored and have a good blue color. However, the scar is rather large and watery and they seem rather susceptible to the mummy berry disease. The bush bears heavy crops for its size but is a bit small. Cold resistance of both wood and buds appears good.

GN-87 is good but probably not quite good enough. The berries are usually large and have had a very good blue color in most years. The scar is usually good but the flavor is often too mild. Berries ripen late and are slightly susceptible to mummy berry. The bush is vigorous and yields well. Cold resistance of buds and wood appears good.

The fruit of F-72 is very large, dark colored and tart, ripens late, and is slightly susceptible to mummy berry. The bush is moderately vigorous. The crop has been good in some years but very light in others probably as a result of spring frost.

R-86 usually produces a good crop which ripens late but the berries are small. Their flavor is fair to good and the scar is good. The bush lacks vigor.

U-85 has produced large berries but very few of them. They ripen late, are very firm, have good color and good flavor, but are very susceptible to mummy berry. The bush is only fair in vigor.

Grapes.—A new blue grape, the Cook, which ripens between Worden and Concord, appears to be a worthy addition to the list of blue grapes.

Raspberries.—The Milton red raspberry is the most promising of the New York introductions in every respect except winter hardiness. In this characteristic it is definitely inferior to Latham or Chief. Taylor is too seriously injured by virus diseases to be desirable.

Strawberries.—Among the newer varieties of strawberries under trial, the Midland, Temple, Fairland, and Sparkle look promising. All are good producers of better than average quality and firmness. Temple, Fairland, and Sparkle are also resistant to the Red Stele root disease. On the other hand, Robinson (Scarlet Beauty), which has been highly advertised, has not shown much promise in our trials so far.

DEPARTMENT OF POULTRY HUSBANDRY

F. P. Jeffrey in Charge

Broodiness in Poultry. (F. A. Hays and D. W. Talmadge.) The last generation in the non-broody line included 80 females. One individual exhibited broody behavior in the first laying year with but a single broody period. Most of these females have been retained to test for deferred broody behavior. This generation again demonstrated our inability to completely eliminate the broody instinct by selective breeding.

In the fall of 1947 about 80 females of different ages in the non-broody line were given prolactin injections to test for broody inheritance. Each female was in active laying and received 50 Internatonal units of prolactin intramuscularly. With very few exceptions, egg laying stopped within two days and was not resumed for 15 or 20 days. This treatment failed to initiate broody behavior in any of the birds.

Another lot of prolactin that is believed to be free of other hormone fractions is now being used to test all females in this line as a guide to future breeding operations.

Genetic Laws Governing the Inheritance of High Fecundity in the Domestic Fowl. (F. A. Hays and D. W. Talmadge.) Several phases of the fecundity problem have been investigated and results published during the year.

Selective breeding has considerable value in developing high and low viability lines of Rhode Island Reds. Further evidence has been presented on the inheritance of intensity of laying. Progeny testing emphasizes the scarcity of superior sires and demonstrates their importance in breeding for high fecundity. Rather extensive colorimetric studies of feather pigments in Rhode Island Reds suggest that dense feather pigmentation depends on a series of recessive genes. The decline in egg weight in warm weather is definitely associated with decreased body weight and reduced feed consumption. This decline in egg weight is insignificant in this latitude. Hatchability has been shown to decrease with increased age of parents and the decline appears to be associated in part with higher embryonic mortality.

A Study of Fertility Cycles in Males. (F. A. Hays and D. W. Talmadge.) Pregnant mare serum has not been effective in activating old males to high fertility in natural matings. Thyroxine gave no positive effects for the same purpose. Artificial light appears to offer possibilities and further tests are being made concerning amount and duration.

An extensive study in females has demonstrated that as viability increases fertility decreases. Apparently high concentration of the female sex hormone concerned with fertility renders the bird more susceptible to diseases such as the paralysis complex.

Secondary and Adult Sex Ratio in Relation to Hatchability. (F. A. Hays.) High and low hatchability lines started in 1945 have been continued and complete hatching records have been secured. The search for lethals has been continued and the first to appear was the type of chondrodystrophy first reported by Hays in 1944. There is evidence that females are likely to predominate in early embryonic deaths while males are more abundant in dead embryos from the eighteenth day on.

Considerable success has accompanied the establishment of high and low hatchability lines but further selective breeding appears to be necessary.

Breeding for High and Low Incidence of Internal Defects in Hen's Eggs. (F. P. Jeffrey and C. E. Walker.) Breeding results indicate that the inherited tendency to produce meat spots in fresh laid eggs is largely independent of the inherited tendency to produce blood clots. Egg shell color in the low meat spot line is now considerably lighter than in the high meat spot line.

Breeding White Plymouth Rocks for Eggs and Meat. (F. P. Jeffrey.) A new sex linkage relationship has been discovered in a strain of White heavies. This autosomal dominant plus the factor for silver allows the production of 100 percent white offspring when white males are mated with Rhode Island Red females.

The reciprocal mating yields red daughters (with no black in plumage) and white sons. It has not yet been determined whether this "new" factor for dominant white is identical with the well-known dominant white as found in the Leghorn, is an allele of it, or is a new independent factor.

SEED CONTROL

Frederick A. McLaughlin in Charge

Enforcement of the Seed Law, together with the desire of seedsmen to comply with requirements of this Act, and a growing interest of the public in good seed, has greatly increased the number of service samples sent to the seed laboratory for testing. From July 1, 1947, to June 30, 1948, 6958 service and inspection samples of seed were received and worked at the laboratory, an increase of 1105 samples over the previous year. The laboratory also received and cleaned 101 lots of tobacco seed.

Analysis of inspection samples shows that most seedsmen have complied with label requirements of the Seed Law. A large part of the violations found are technical in nature rather than flagrant.

Operation of the Seed Law is reported in an annual bulletin issued for that purpose.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Control Service. (H. Van Roekel, K. L. Bullis, G. H. Snoeyenbos, O. S. Flint, F. G. Sperling, M. K. Clarke, O. M. Olesiuk, and E. M. Allen.)

1. *Pullorum Disease Eradication.* During the 1947-48 testing season 605 flocks (including chickens and fowl other than chickens) were tested in 12 counties. A total of 1,272,547 chicken blood samples was tested, of which 0.10 percent were positive. A total of 24,564 blood samples from fowl other than chickens was tested. None of these were positive. Sixteen "breaks" were detected and of this number 13 revealed less than 0.5 percent reactors. The majority of the "break" flocks were retested until the flocks obtained a negative status. Non-reacting chicken flocks numbered 476 and represented 1,185,852 birds or 97.20 percent of all birds tested.

The testing results reveal further progress in the establishment and maintenance of pullorum-free flocks. A more detailed discussion on the pullorum testing work will be given in the Twenty-eighth Annual Report of Pullorum Disease Eradication in Massachusetts.

2. *Salmonella pullorum Antigenic Forms.* During the 1947-48 testing season *S. pullorum* cultures were isolated and typed for antigenic form from 34 birds selected from 20 flocks in the State in which pullorum infection was detected by routine flock testing. Twenty-three birds from thirteen of these flocks were found to be infected with a Standard form of *S. pullorum* (IX, XII, $XII_2\pm$, $XII_3\mp$). Six birds from three flocks were found to be infected with a Variant form (IX, XII, $XII_2\mp$, $XII_3\pm$). The remaining five infected birds from four flocks yielded cultures with antigenic characteristics between those of Standard

and Variant forms and apparently were in active form variation at the time of isolation. This was supported by the fact that after several transfers on artificial media their antigenic form tended to become Standard. It is of interest to note that to date all infected flocks (including Standard, Intermediate, and Variant forms of infection) were originally identified by the Standard form antigen. Variant form infection has not been a problem in the establishment and maintenance of pullorum-free flocks in Massachusetts thus far.

Previous to March 31, 1948, twenty-seven *S. pullorum* cultures, isolated from specimens representing acute infections in nine flocks, were typed for antigenic characteristics. One culture was Variant in form. Cultures from eleven birds from two chick flocks, both of which were hatched from eggs laid by a flock infected with an Intermediate form organism, showed mixed culture forms, Standard, Intermediate, and Variant forms being found in individuals. The remaining fifteen cultures from six flocks were of Standard form.

Additional work is being done to determine the practical significance of form variation in *S. pullorum* as it affects antigenic response and agglutination reactions.

3. *Diagnostic Service.* During the calendar year of 1947, 4,627 specimens were received in 1,010 consignments, of which 660 were delivered in person. This represents a considerable increase in the number of consignments, 146 of which were for immunity tests in order that the flocks might be included in the infectious bronchitis and Newcastle disease programs. The specimens were classified as follows:- 4,116 chickens; 393 turkeys; 30 canaries; 12 canine feces; 11 each of mink, and rabbits; 10 pheasants; 6 each of fish and pigeon; 4 rats; 3 each of bovine semen, ducks, and ruffed grouse; 2 each of bovine feces, equine semen, grosbeaks, guinea pigs, and swine; and one each of bovine, bovine fetus, bovine organs, bovine pus, goat feces, meat, ovine organs, rabbit liver, and swan.

Tumors (110), coccidiosis (82), and fowl paralysis (57), which in past years have been consistently among the most common diagnoses, were displaced by infectious bronchitis (150) and Newcastle disease (115). In 113 cases of respiratory infection a definite diagnosis was not made. Avian tuberculosis was identified on two premises. Fowl cholera was diagnosed on 18 premises. Eleven of these represent new known foci of infection, and on two others there had been no evidence of infection for four and seven years, respectively. Fowl typhoid was identified in 24 outbreaks on 20 premises, 15 of which represent new known foci of infection.

The number of outbreaks of fowl typhoid during the past four years suggests that this disease, if not checked, may become a serious problem to the industry. During the past two years, each flock was visited or the owner was otherwise contacted to assist in formulating an eradication program. Agglutination tests are conducted in flocks which are not depopulated and where testing seems indicated. The flock owners are contacted during the year following the outbreak to obtain information on the success of the eradication program. Attempts are being made to inform those engaged in the poultry industry concerning the prevalence and potential dangers of the disease. Infection reappeared in 1947 on four of the 19 premises which were known to have been infected in 1946. The effort to eradicate infection on two of these premises was believed to have been insufficient. Infection on the third was believed to have been carried over in an uncleaned pig pen adjacent to the range. An explanation was not found for the reappearance of infection on the fourth premise.

A severe conjunctivitis and keratitis in young chickens was present in five consignments. This apparently is a relatively new condition as only five cases

were observed in the previous four years and five cases were observed in the spring of 1948. Affected birds were two to 18 weeks of age (average 11 weeks). The percentage of birds affected averaged about 12 percent. The birds keep the eyelids closed, sometimes manifesting marked irritation by rubbing the eyes on their wings. There is slight lacrimation with marked congestion and moderate edema of the conjunctiva. Ulceration of the cornea varies from small areas on the posterior surface to almost complete involvement. Affected birds sit quietly for one to two weeks, eating and drinking very little, with resultant rapid loss in weight. Improvement is gradual thereafter, requiring one to three months, and, in some birds, there remains some cloudiness of the cornea. The cause of the condition has not been established.

Pox was observed in two canary flocks with a resultant mortality of approximately 35 and 65 percent respectively. Available information indicates that only vaccine of canary origin is of value in immunizing canaries. Vaccine supplied by Dr. F. R. Beaudette of the New Jersey Agricultural Experiment Station was introduced into each of these flocks at a time when entirely favorable results could not be expected. The vaccination apparently influenced the course of the disease favorably in one flock and was used too late in the other flock.

The 393 turkeys were received in 77 consignments, representing about 40 percent less material than was received in each of the previous two years. Paratyphoid infection, enterohepatitis, and coccidiosis were the conditions encountered most frequently. Erysipelas, which was quite prevalent the previous year, was identified in only one case. Newcastle disease was identified in two outbreaks. The mortality in poults, apparently infected when received, was about 40 percent over a four weeks' period. In an affected breeding flock, which manifested only mild respiratory symptoms, the egg production declined approximately 50 percent and the egg shell quality was definitely affected. Field evidence indicated that the poults hatched were not affected.

4. *Flock Mortality Studies.* No significant new information was obtained in this continuation of examinations on the flock maintained at the University for genetic studies. The number of birds examined was much smaller than in previous years, reflecting in part lower mortality in the flock. Up to January 1, 1948, necropsies were made on 117 birds (92 females and 25 males) from the flock hatched in the spring of 1946. *Pasteurella avicida* was recovered from lesions of the feet of one male. The last previous isolation of this organism in the flock was in 1939 and it was not causing serious trouble at that time. No unusual disease outbreaks were noted. Reproductive disorders, cannibalism, tumors, and kidney disorders were the principal causes of mortality. Gross examination revealed lymphocytoma in only one female and one male, fowl paralysis in three females and one male, and myelocytoma in four females.

5. *Infectious Bronchitis Control.* During 1947 a total of 263 flocks was enrolled in the infectious bronchitis control program, an increase of 46 flocks over the previous season. The results continue to be satisfactory and more flock owners are beginning to realize the value of a flock immune to bronchitis. During the past year 177 flocks were tested for immunity to infectious bronchitis, 133 of which were found to be immune, 27 susceptible, and 17 questionable.

The poultry bronchitis laboratory also tested flocks for Newcastle disease. A total of 300 flocks was tested, 115 of which were found positive and 185 negative.

Thirty-six flocks were found to be positive for both Newcastle disease and infectious bronchitis. Newcastle disease was identified in all but one county

(Dukes) during 1947. Both infectious bronchitis and Newcastle disease are very prevalent in Massachusetts and represent a serious economic menace to the industry.

During 1947 a Newcastle disease immunization project was initiated. A preliminary report of the results has been published as Contribution Number 645, Massachusetts Agricultural Experiment Station. The encouraging results have permitted the development of a State-wide flock vaccination program on an investigational basis.

During the past year the viability of Newcastle virus in infertile eggs held at incubator temperature (99° F.) and humidity (wet-bulb reading 90° F.) has been investigated. Preliminary results reveal that the virus may remain viable under those environmental conditions for at least 29 days.

The resistance of the virus to formaldehyde fumigation was also investigated. Preliminary results reveal that whole egg shells with only one end broken and the outer surface contaminated with Newcastle virus require at least one hour of triple strength fumigation (105cc. formalin and 52½ grams potassium permanganate per 100 cubic feet of space, at a temperature of 99° F. and a wet-bulb thermometer reading of 86°) to destroy the virus. However, when egg shells were finely crushed and contaminated with virus, one-hour fumigation was insufficient to kill the virus.

These investigations on the behavior of the virus under various physical, chemical, and thermal influences are being continued.

Mastitis Testing Laboratory. (W. K. Harris.) Laboratory examination of milk samples for the diagnosis of bovine mastitis was first reported by the laboratory on samples received March 24, 1947. Following the examination of samples, group segregation of the cows is recommended according to the results of the test. The group numbers shown on the report of test and their significance are as follows:

Group I—Negative.

Group II—Positive for mastitis not due to *Str. agalactiae*. Such cases are most commonly due to infection with Staphylococci, *Str. uberis*, *Str. dysgalactiae*, or coliform organisms. This group includes cows having non-infectious mastitis.

Group III—Positive for *Str. agalactiae*.

During the period from March 24 to June 30, 1947, inclusive, 4,607 samples from 1,166 head in 21 State-owned herds were tested. Of these, 691 cows were placed in Group I, 236 in Group II, and 239 in Group III. No tests on private herds were completed during the period. During the fiscal year of 1947-48 a total of 13,645 milk samples was tested. There were 102 samples submitted that were unsuitable for testing. From cows in State-owned herds 9,113 samples, and from private herds 4,532 samples were examined. The above figures include both partial and complete herd retests.

In order to determine the incidence of mastitis in the private herds tested, a summary of the initial tests was made. Initial tests were made on samples from 1,157 head, representing 75 herds, of which 56 had less than 20 cows each and 19 had 20 cows or more. The percentage of cows found infected is shown as follows:-

	Herds	Head	Percentages in Groups I	II	III	Percentage Infected
Under 20 cows	56	465	59	24	17	41
20 cows or more	19	692	47.5	19.5	33	52.5
Combined	75	1,157	52	21.5	26.5	48

It appears significant (1) that the percentage of Group III cows in the 19 herds is approximately twice as great as in the 56 smaller herds, and (2) that nearly one-half of all the cows tested had mastitis on the initial test. A study of the test results of the 75 herds revealed that 81 percent of the herds had some cows in Group II, 47 percent had some cows in Group III, and 37 percent had cows in both of these groups.

The percentage of cows having mastitis in the 22 State-owned herds was found to be approximately the same as in private herds, but a higher proportion of the cows, 38 percent, was in Group III. In Group II there were 11.5 percent. The average number of cows milked in the State-owned herds was 54, while in the private herds it was 15.

WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon, In Charge

The members of the research staff of the Waltham Field Station are assigned to this branch by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Refer to reports of these Departments for results of investigations conducted at this Station.

PUBLICATIONS

Bulletins

440 Apples as Food. By William B. Esselen, Jr., Carl R. Fellers, and Marie S. Gutowska. 32 pp. August 1947.
Apples owe their widespread popularity to their attractiveness and palatability. Now with recognized food values assigned to them, apples also assume importance as a "protective food" in the American diet. This bulletin summarizes information on composition and nutritive value.

441 Annual Report for the Fiscal Year Ending June 30, 1947. 72 pp. September 1947.
The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

442 Mortality Studies in Rhode Island Reds, II. By F. A. Hays. 8 pp. July 1947.
Mortality from all causes is one of the most important problems of poultrymen. This report gives the final results of an attempt to breed lines of Rhode Island Reds resistant or susceptible to mortality from all causes.

443 The Inheritance of Intensity of Laying in Rhode Island Reds. By F. A Hays. 12 pp. July 1947.
Intensity of laying is one of the most important characters associated with high fecundity. Particular attention is given in this report to different methods of measuring intensity and to evidence regarding its inheritance.

444 Fertilizer Experiments on an Abnormal Orchard Soil. By J. K. Shaw. 16 pp. illus. December 1947.
This bulletin reports the response of fruit plants to a long-continued fertilizer program of nitrogen, phosphorus, potash, and lime. The conditions were unusual; but the results are of value in suggesting right and wrong fertilizer programs in the orchard.

446 Septic Tank Studies. By James E. Fuller. 19 pp. illus. February 1948.
This bulletin reports a study of the operating efficiency of septic tanks when sewage is retained for periods less than the 24 hours usually recommended. Management observations and chemical and biological tests gave evidence in favor of the conventional practice of holding sewage in tanks for 24 hours or more.

447 Cranberry Growing in Massachusetts. By Henry J. Franklin. 44 pp. illus. April 1948. (Revision of Bulletin 371.)
Massachusetts produces more than half the cranberries grown in the world. It is, therefore, considered desirable to issue a bulletin dealing with the cultural practices of this important crop.

448 The Valuation of Dairy Farm Property for Local Tax Purposes in Massachusetts. By Alfred A. Brown. 16 pp. April 1948.
Valuations indicate the community's estimate of the property owner's obligation to it; yet they are frequently overlooked in the constant concern over taxes. This report attempts to give to valuations the importance they deserve and to suggest ways of increasing the objectivity of the valuation process.

Control Bulletins

132 Inspection of Commercial Feedstuffs. By Feed Control Service Staff. 36 pp. June 1947.

133 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 20 pp. July 1947.

134 Twenty-Seventh Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. July 1947.

135 Seed Inspection. By F. A. McLaughlin. 33 pp. November 1947.

Meteorological Bulletins

703-714, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By H. N. Stapleton. 4 pp. each.

Reports of Investigations in Journals

Numbered Contributions

553 Immunization against a lymphoid tumor of the chicken. IV. Use of miscellaneous tests. By Carl Olson, Jr. Cornell Vet. 37 (3):231-240. 1947.

582 The hemicelluloses of maize cobs and rye straw. By Emmett Bennett. Jour. Agr. Res. 75 (1):43-47. 1947.

600 Variation in composition of winter squashes. By Arthur D. Holmes, C. Tyson Smith, and William H. Lachman. Food Res. 13 (2):123-127. 1948.

611 Role of kaolin in anion sorption and exchange. By Dale H. Sieling. Soil Science Soc. Amer. Proc. 11 (1946):161-170. 1947.

612 Some characteristics of mare's colostrum and milk. By Arthur D. Holmes and Harry G. Lindquist. Jour. Amer. Diet. Assoc. 23 (11):957-961. 1947.

613 The use of oil sprays as selective herbicides for carrots and parsnips III. By William H. Lachman. Amer. Soc. Hort. Sci. Proc. 49:343-346. 1947.

614 Pre-emergence spraying for weed control in vegetables. By William H. Lachman. Amer. Soc. Hort. Sci. Proc. 49:339-342. 1947.

615 Development time from bloom to maturity in cultivated blueberries. By J. S. Bailey. Amer. Soc. Hort. Sci. Proc. 49:193-195. 1947.

617 Stability of reduced ascorbic acid in mares' milk. By Arthur D. Holmes and Carleton P. Jones. Jour. Nutrition 34 (1):113-119. 1947.

622 Testing quaternary ammonium sanitizers as used in the dairy industry. By W. S. Mueller, D. B. Seeley, and E. P. Larkin. Soap and Sanitary Chemicals for September 1947.

623 Ascorbic acid content of hen's eggs. By G. H. Satterfield, T. A. Bell, F. W. Cook, and Arthur D. Holmes. Jour. Amer. Dietet. Assoc. 23 (12):1052-1054. 1947.

624 Male sex hormones and artificial light as activators in the spermatogenesis of adult males. II. By F. A. Hays. Poultry Sci. 27 (1):3-6. 1948.

625 Vegetative propagation of kudzu. By W. L. Doran and A. B. Beaumont. Jour. Amer. Soc. Agron. 39 (9):834-835. 1947.

626 Plumage color genes in White Plymouth Rocks and White Wyandottes. By F. P. Jeffrey. Poultry Sci. 26 (5):526-528. 1947.

627 Antioxidants in vegetable oils. By John E. W. McConnell. Amer. Perfumer and Essential Oil Rev. 50 (3):241-243; (4):346-349. 1947.

631 Further studies on the use of calcium chloride to maintain firmness in canned and frozen apples. By W. B. Esselen, Jr., W. J. Hart, Jr., and C. R. Fellers. Fruit Prod. Jour. and Amer. Food Mfr. 27 (1):8-13. 1947.

632 The freezing of swordfish. By Antonio Lopez-Matas and C. R. Fellers. Quick Frozen Foods 10 (3):72-75. 1947.

633 Thyroxine and artificial light as activators in the spermatogenesis of males. By F. A. Hays. Poultry Sci. 27 (1):84-86. 1948.

636 Permanency of synthetic ascorbic acid added to milk. By Arthur D. Holmes and Carleton P. Jones. Jour. Dairy Sci. 31 (2):99-102. 1948.

637 Viability and fertility in Rhode Island Red females. By F. A. Hays. Poultry Sci. 27 (2):186-193. 1948.

638 Extraction of copper from soil as affected by soluble components of oat straw and alfalfa meal. By Charles Hurwitz. Soil Sci. 65 (3):275-280. 1948.

641 The value of the progeny test in males. By F. A. Hays. Amer. Nat. 81:454-460. 1947.

643 Some studies using isopropyl n-phenyl carbamate as a selective herbicide. By William H. Lachman. Amer. Soc. Hort. Sci. Proc. 51:541-544. 1948.

644 Some effects of blossom removal on vegetative development and defoliation in determinate tomato plants. By William H. Lachman. Amer. Soc. Hort. Sci. Proc. 51:341-345. 1948.

645 Immunization of chickens against Newcastle disease. By H. Van Roekel, F. G. Sperling, K. L. Bullis, and O. M. Olesiuk. Jour. Amer. Vet. Med. Assoc. 112 (851):131-132. 1948.

646 A Valsa associated with Cytospora canker of spruces. By David H. Marsden. Phytopathology 38 (4):307-308. 1948.

648 Effect of different mulches upon the nutritive value of tomatoes. By Arthur D. Holmes, C. Tyson Smith, Charles Rogers, and William H. Lachman. Soil Sci. 65 (6):471-475. 1948.

650 Prepared fresh McIntosh apple slices. By W. B. Esselen, Jr., C. L. Rasmussen and C. R. Fellers. Fruit Prod. Jour. and Amer. Food Mfr. 27 (9):276-279. 1948.

651 Susceptibility of Cucurbitaceae to squash borer. By W. D. Whitcomb and W. J. Garland. Amer. Soc. Hort. Sci. Proc. 51:445-447. 1948.

652 Controlling witchgrass by spraying with Ammate or Atlacide. By John S. Bailey. Amer. Soc. Hort. Sci. Proc. 51:563-564. 1948.

660 When using pressure canners. By W. B. Esselen, Jr., and C. R. Fellers. Jour. Home Econ. 40 (6): 318-319. 1948.

661 Canned and frozen baked McIntosh apples. By C. L. Rasmussen, W. B. Esselen, Jr., and C. R. Fellers. Fruit Prod. Jour. and Amer. Food Mfr. 27 (8): 228-229, 265. 1948.

665 A troublesome mold and its control in gas-purifying sponge. By E. F. Guba and E. V. Seeler, Jr. Econ. Bot. 2 (2):170-177. 1948.

Miscellaneous

Barn hay curing. By H. N. Stapleton and J. G. Archibald. Better Goat-keeping 3 (11):706-707. 1948.

Fungicides applied in fertilizers for the control of cabbage clubroot and damping-off. By William L. Doran. Phytopathology 37 (11):848. 1947. (Abst.)

Get out your knife and see how you can multiply. By William L. Doran. Horticulture 25 (16):447, 461. 1947.

Eradicating apple foliage scab with summer sprays. By E. F. Guba. Phytopathology 37:848. 1947. (Abst.)

Dutch elm disease. By Malcolm A. McKenzie. New England Council Report on Regional Meeting, Nov. 7, 1947. pp. 6-7.

Provident trees. By Malcolm A. McKenzie. Nature Mag. 4 (3):148. 1948.

Dutch elm disease is on the march. By Malcolm A. McKenzie. News of New England Agriculture, Oct. 23, 1947. pp. 1-2.

Pest control on ornamentals. By W. D. Whitcomb. Horticulture 26 (5):196-199. 1948.

Fight bugs and blights (pest control schedule for perennials). By W. D. Whitcomb. Horticulture 26 (6):234, 244-245. 1948.

Strawberry and raspberry insect pests. By W. D. Whitcomb. Mass. Fruit Growers Assoc., Report of the 54th Annual Meeting. 1948.

Laboratory tests in controlling pillbugs. By F. R. Shaw, A. I. Bourne, and W. B. Hathaway. Jour. Econ. Ent. 39 (6):818-819. 1946.

Control of black scale on gardenias in commercial greenhouses. A. I. Bourne and F. R. Shaw. Jour. Econ. Ent. 40 (3):429-430. 1947.

Chironomid larvae in a tobacco seed bed. By F. R. Shaw and A. I. Bourne. Jour. Econ. Ent. 40 (5):749. 1947.

Experiments with benzene hexachloride and similar materials on vegetables and tobacco. By W. D. Whitcomb and A. I. Bourne. Mass. Agr. Expt. Sta. Spec. Cir. (mimeographed) 8 pp. March 1948.

The Mexican bean beetle and its control. By A. I. Bourne. Mass. Ext. Service Spec. Cir. 15 (Rev.).

Controlling gladiolus thrips. By A. I. Bourne and F. R. Shaw. Mass. Ext. Service Spec. Cir. 16 (Rev.).

Ants outdoors. By A. I. Bourne. Mass. Ext. Service Spec. Cir. 33 (Rev.).

Insecticides for the control of the European corn borer in early sweet corn. By A. I. Bourne. Mass. Ext. Service Spec. Cir. 76 (Rev.).

DDT for plant pest control. By W. D. Whitcomb, A. I. Bourne, and F. R. Shaw. Mass. Ext. Service Spec. Cir. 135 (Rev.).

The use of DDT for control of household pests. By H. L. Sweetman and A. I. Bourne. Mass. Ext. Service Spec. Cir. 136 (Rev.).

Processing foods in glass containers. By W. B. Esselen, Jr., M. J. Powers, C. T. Townsend, and J. M. Reed. The Canner 106 (9):16, 18, 34. 1948.

Use of commercial dips in the preservation of swordfish steaks stored at 32° to 40° F. By A. Lopez-Matas and C. R. Fellers. Fishing Gazette for August 1947. 2 pp.

Home Canning: fruits—vegetables—poultry—meat—fish and special products. By W. R. Cole, W. B. Esselen, Jr., and C. R. Fellers. Mass. Ext. Service Leaflet 142. 40 pp. June 1948.

This spring grow your own Delphiniums. By C. J. Gilgut. Flower Grower 35 (5):223, 254-256. March 1948.

How to grow Gladiolus. By C. J. Gilgut. Horticulture 26 (5):191, 206-207. May 1948.